Chapter 3. Soils, Geology, and Landforms, and Their Relationship to Vegetation

Soil Setting

by Terry J. Hughes

The Upper Gunnison Basin is within the South Central and North Central Highlands Sections of the Southern Rocky Mountain Open-Woodland-Coniferous Forest-Alpine Meadow Province as described in USDA Forest Service (1994). This area consists mostly of broad, elevated, north south strips of dominantly granitic material, flanked by steeply dipping sedimentary rocks.

The northern portion of the basin is characterized by steep glaciated mountains with many steep, U-shaped valleys. The glacial activity scoured the upper peaks and ridges, depositing material of mainly granitic origin at different times throughout recent geologic history, resulting in a large variety of surface ages and landform shapes.

The middle to southern portions of the basin have less dramatic mountainous terrain, and consist of more open broad valleys, rounded hills, mesas, buttes and older pediment surfaces relating to past erosional activities. The geologic makeup ranges from older, reworked granitic material, recent alluvial deposits, some sedimentary material (mostly Dakota, Mancos, Mesa Verde, and Morrison formations). There are some granites, gneiss, and schists weathered in place, and even some rhyolite, andesite, basalt and tuffs.

There is a wide variety of soils in the Upper Gunnison Basin. Soil, as such, is a natural occurring body at the surface of the earth that has characteristics resulting from the action of forces of the environment upon parent materials over a period of time. The specific character of the soil in any landscape differs from place to place, depending on the nature and intensity of the factors that control its development.

Five major factors are recognized as being influential in the development of the soil at any specific location. Briefly stated, these five factors are climate, living organisms, time, relief, and parent material. Soil is the result of the combined effects of these five factors, and soil differences are due principally to the relative importance, or strength of the various factors. In mountainous areas, such as the Upper Gunnison Basin, changes in one or more soil-forming factors can occur in relatively short distances. The many micro-climates – the results of differences in elevation, air drainage, and topography (with its modifying subfactors of slope gradient and aspect) – and the accompanying differences help create many kinds of soils. Changes in other factors – parent materials, topographic position, and land surface age – further increase the number of different kinds of soil in the area. Parent material and geologic material vary widely in physical, chemical and mineral properties. There are great differences in the length of time that they have been subjected to the effects of climate and biological activity.

An often overlooked form of influence to both soil and vegetation is the human impact, either direct or indirect. Direct impacts such as cultivating, blading, or even removing parts of the soil can drastically alter soil and vegetation characteristics and potentials. More subtle indirect forms of influence could include grazing activities, controlling water movement (either knowingly or unknowingly), and exclusion of naturally occurring fire sequences (which could alter vegetation compositions, nutrient cycling timing, and erosion rates).

The system most commonly used in the United States to describe soil and soil characteristics is that used by the National Cooperative Soil Survey (NCSS), developed by the Natural Resources Conservation Service (NRCS, formerly the Soil Conservation Service). It is based on properties of the soils that can be easily observed and measured. Various soil properties and characteristics are used to group similar soils or separate those that are dissimilar. We select specific characteristics for use in soil identification based on our collective knowledge of what affects plant growth, how a particular set of characteristics react to different treatments and our understanding of soil genesis and morphology. The specific terminology used to describe soil and soil characteristics are found in "Keys to Soil Taxonomy" (Soil Survey Staff 1996) and the "Soil Survey Manual" (Soil Survey Division Staff 1993)." Some of those terms were used in the Ecological Classification of the Upper Gunnison Basin.

Various soil surveys of the area were reviewed to determine overall general soil characteristics. These included the Taylor River Soil Survey (Fox 1977), the Soil Survey of The Gunnison Area (Hunter and Spears 1975), the Grand Mesa-West Elk Soil Survey, the Cochetopa Soil Survey and the Ouray Soil Survey. All of the soil surveys have followed procedures as required by the NRCS and are part of the NCSS Program. The surveys are of various ages and for the most part have been designed to address issues that do not require precise knowledge of small areas or very detailed soils information. Dominant soil characteristics

over large areas have been identified through interpretation of aerial photos, field verification and extrapolation of known areas to other areas with similar vegetation, landform, and geologic characteristics. The smallest delineations identified on photos and maps typically range 20-80 ac (8-35 ha).

The observations made during the field work of this ecological classification were on units of land smaller than those identified in most of the soil surveys that are in the area. As a result, soil characteristics observed may appear to not match those identified in the soil survey. This is not to say that the soil survey is "wrong," but that the level of investigation used in the classification is below the level of the existing soil survey information and should be considered a more intensive level of detail.

Soils and vegetation are influenced by some of the same factors: climate, relief, organisms, parent material, and to a certain degree, time. But soils do not respond to those factors at the same proportional rates as vegetation does. For this reason, a particular Soil Series (a fairly specific level of soil identification), may not always be directly correlated to a particular habitat type. For example, it was observed by Tiedeman and others (1987), that parent material may play a very important role in the classification of the soils of an area, but may have only a minor impact upon the plant association in comparison to some other factor such as relief. It has also been observed that sometimes those soil properties suspected of playing important roles in vegetative differences of various habitat types are not among the characters emphasized at the level of soil classification used during the general level soil survey in the west and of this area. On the other hand, since both soils and existing vegetation are influenced by the same forming factors, and are frequently correlated to some degree, both are useful in the identification of habitat types.

To the degree possible (considering limited budgets, minimal involvement of soil scientists, and no organized soil correlation process), soil characteristics were observed at vegetative reference points. An attempt was then made to classify the soil using terms and procedures identified in Soil Survey Staff (1996). Classification was based on field observations only, no laboratory data was used.

A listing of soils found in the Upper Gunnison Basin can be seen in Appendix B. The soils represent six out of 12 major soil orders. Those include predominately Alfisols, Mollisols, Inceptisols, with some Histosols in wet areas, some Aridisols on lower dry sites, and some Entisols on shallow, less developed locations.

Geology
by Joseph Pecor

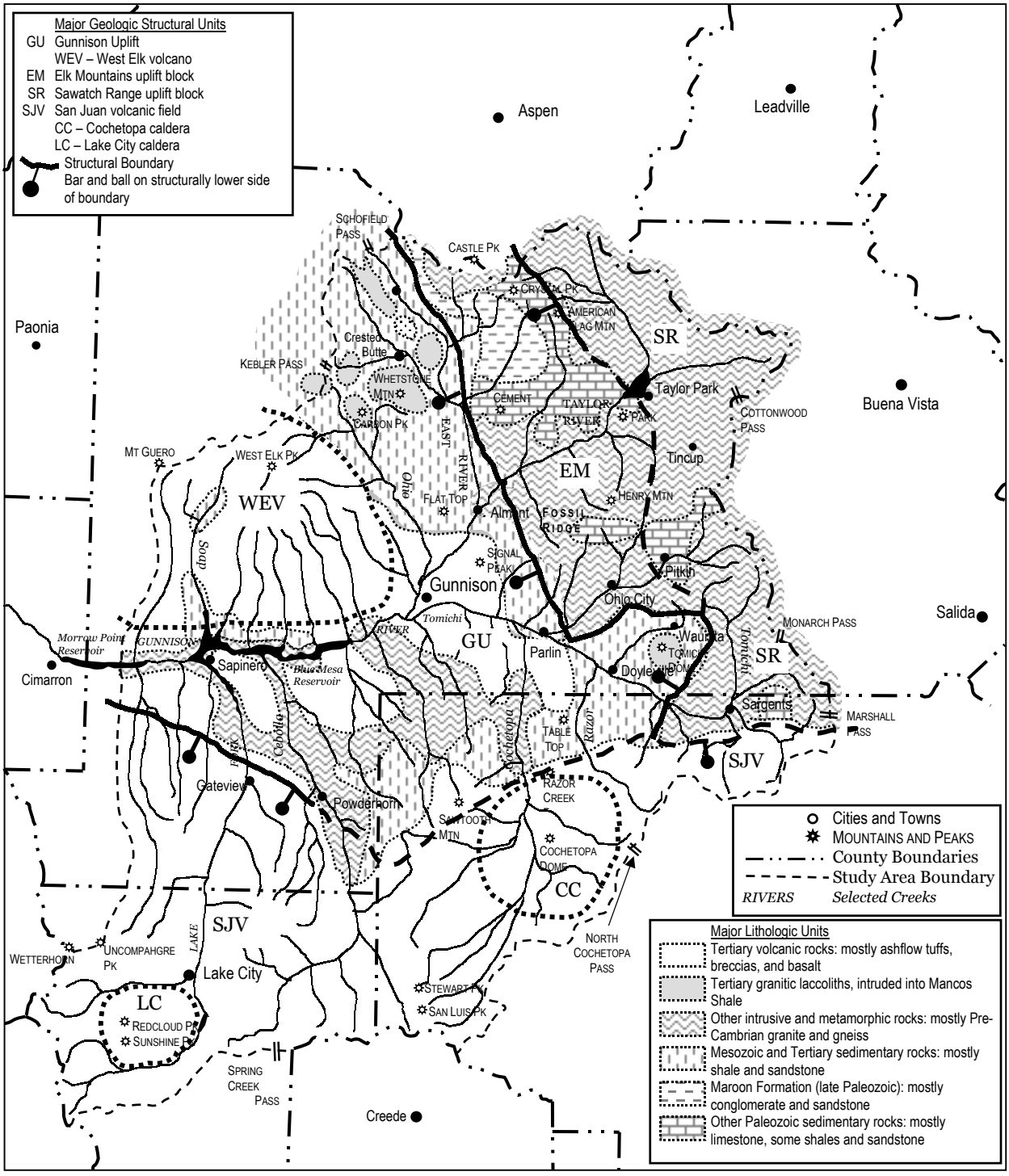

Fig. 3-1. Major lithologic units and major geologic structural units of the UGB. Note that Tertiary volcanic rocks within the UGB are unshaded.

The Upper Gunnison Basin (UGB) has a wide variety of rock types ranging in age from Precambrian granitic and metamorphic rocks to mid-Tertiary volcanic rocks. In between, there are also marine and terrestrial sedimentary rocks of all sorts, as well as other granitic rocks. Many kinds of landforms are produced by the interaction of these rock types with several geomorphic processes, including stream erosion and deposition, glaciation, slope failure, and volcanic flow deposition.

For the purposes of this discussion, the various rock types can be conveniently grouped into six major lithologic units (Fig. 3-1).

Tertiary volcanic rocks

The most widespread lithologic unit consists of Tertiary volcanic rocks, which are the most abundant rocks throughout the southern and western part of the UGB.

The southern part is in the San Juan Volcanic Field, which consists of several calderas from which have erupted extensive flows of volcanic ash, volcanic breccia, and lava flows (most notably, basalt).

The ash flows extend in gently sloping sheets far to the north of their sources, capping parts of the Gunnison Uplift (Fig. 3-1) and lapping up onto the southern slopes of the West Elk Volcano, discussed below. They have been dissected by stream erosion and now form elongated, three-sided "mesas" often with channery residual soils on top, and coarse, colluvial soils on the steep side slopes.

The breccias form steep, extremely rocky slopes. The basalt flows, being youngest, are on top of everything else and have been dissected into high plateaus and flat-topped ridges, with clay-rich residual soils on top. The flows are relatively thin and form only the uppermost part of the sideslopes as "rimrocks," but typically are a major source of rock fragments in the upper layers of the soils on the slopes below.

Northwest of Gunnison, on the northern edge of the Gunnison Uplift (Fig. 3-1), repeated eruptions of the West Elk Volcano, accompanied by huge debris flows, produced the volcanic breccia of the West Elk Mountains. These mountains have long sloping ridges, with broad, rounded summits, separated by deep steep-sided valleys, many of which begin in glacial cirques. The soils formed on these breccias are usually extremely rocky and often quite sandy.

Precambrian granites and gneisses

The next most widespread lithologic unit consists of Precambrian granites and gneisses (banded metamorphic rock) which form the hard, crystalline "basement" underlying the entire region. This unit also includes the recent granites which have intruded the basement rocks.

Precambrian granites and gneisses have been exposed in the southern part of the Gunnison Uplift, and in the Elk Mountains and Sawatch Range uplift blocks, in the central and northeast parts of the UGB. These have been increasingly elevated (in the order named) thus exposing increasing amounts of these rocks. The Elk Mountains and Sawatch Range have been extensively glaciated and thus have sharp, jagged ridges and extremely steep sideslopes with rock slides and much exposed bedrock, and broad cirques and valley floors with moraines and other glacial deposits on which very coarse, often bouldery, soils have formed.

A notable physiographic feature of the northeastern part of the UGB is Taylor Park, which is a large elongated depression into which several glaciers converged and deposited moraines and outwash terraces. Most of the soils here are very deep, sandy, and rocky; they are consequently extremely well-drained, except in numerous depressions where they are often saturated and high in organic material.

Where Precambrian granites and gneisses have not been glaciated, they form rocky slopes with rusty-colored soils, rich in coarse sand on granite. On gneiss, they form dark, somewhat olive-colored soils, rich in very fine sands.

Mesozoic and Tertiary sedimentary rocks

These rocks are found in the Gunnison Uplift (GU) in the northwestern and central parts of the UGB. In the northwestern part these rocks consist mostly of shales (most notably Mancos Shale), sandstones, and conglomerates.

In the central part of the area, these rocks consist mostly of mudstones, thinly interbedded with soft sandstone (Morrison Formation), between cliff-forming layers of hard sandstone (Junction Creek Sandstone below, Dakota Sandstone above). There are also found some of the same shales as in the northwestern part of the UGB.

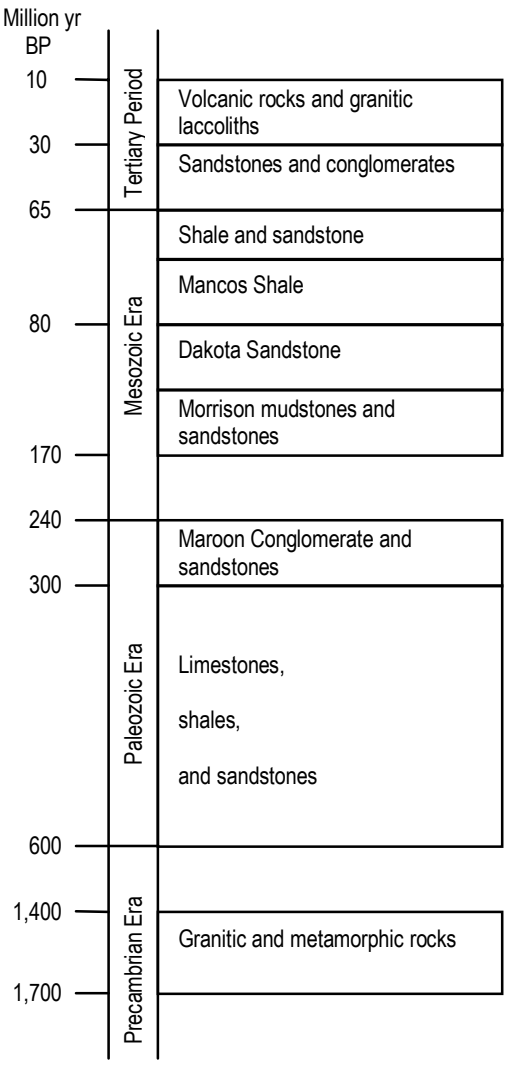

Fig. 3-2. Showing geological ages of rocks commonly found in the UGB.

All the shales are very prone to slope failure, resulting in extensive areas of slumps and earthflows, producing hummocky terrain with highly variable slopes and dark soils rich in clay and silt.

The hard sandstones often form benches on the mountain slopes and, where sufficiently exposed, produce sandy soils. Where they crop out, they also contribute rock fragments to the soils on the slopes below.

The interbedded mudstone and sandstone produce quite variable soils, often rich in clay, and are also prone to slope failure.

Tertiary volcanic laccoliths

This is a relatively minor lithologic unit, most notable for being what creates many of the most prominent mountains in the northwestern part of the UGB, around Crested Butte.

These laccolith mountains consist of granitic rock intruded into Mancos Shale, which has been partially eroded off. Many of these mountains have been at least partially glaciated, producing very steep slopes, often with much exposed rock and fields of talus. Soils on the mountains are very rocky with much coarse sand, contrasting sharply with the clayey soils formed from the adjacent Mancos Shale. The shale soils often have varying amounts of granitic rock fragments derived from the slopes above.

Maroon Formation

This unit occurs in the northern part of the UGB, in the Elk Mountains, and consists of maroon-colored, interbedded conglomerate and sandstone which forms very steep slopes of alternating short cliffs and somewhat less steep “benches.” The soils are extremely coarse and rocky, and often are poorly developed due to continuing erosion.

Other Paleozoic sedimentary rocks

This unit occurs mainly in the Elk Mountain Uplift Block (Fig. 3-1), making up much of the Elk Mountains proper, Fossil Ridge, and the Pitkin area. It also occurs in small, scattered bodies in the southern part of the Sawatch Range.

The rocks are mostly limestones, with lesser amounts of shale and sandstone. The limestones form sheer cliffs where exposed by glaciation in cirque walls, on the sides of Fossil Ridge, for example. Otherwise, these rocks do not produce distinctive landforms.

The soils formed on limestone are rich in clay and silt, and have extremely stony subsurface layers.

Correlation of Ecological Types With Landforms and Soils

by Joseph Pecor

In the following, landform, geology, and soil characteristics and measurements are summarized for each ecological type. Three sample (plot or transect) counts are given: first, total number of samples assigned to that ecological type; second, number of samples used to describe landforms and geology; third, number of samples used to describe soils. The descriptions are given in 'bullet' form to enable the user to compare several ecological types.

In the descriptions of landforms, geology, and soils (left column), the first characteristic listed is the most frequent within the set of samples. In the average calculations (right column), numbers are usually shown in the form *average (minimum-maximum)*. Where only one number is shown in the right column, it represents only one sample.

In the following, those characteristics that are diagnostic are shown in **bold**.

A. Dry Forests (FD)

1. Rocky Mountain Juniper Ecological Series (JUSC2)

FD01 – *Rocky Mountain Juniper/littleseed ricegrass–Stony cobbly gravelly Argiborolls–Steep southerly granitic backslopes, 8,300-9,300 ft* (JUSC2/PIMI7). This ecological type is characteristic of the **Foothills** belt. It is typically located just downslope of sandstone outcrops, where sandstone talus dominates the surface.

No. Samples/L&G/S:	8/6/5	Average Elevation:	8,920 ft (8,360-9,240 ft)
Landforms and Geology:		Average Aspect:	171°M (r = 0.60)
Soil creep slopes or backslopes		Average Slope:	39% (29-47%)
Undulating to linear horizontally, concave to linear vertically		Average Coarse in Soil:	56% (35-73%)
Granites, less often Cretaceous sandstones or shales		Average Soil Depth:	51 cm (28-80 cm)
Soils:		Average Mollic Depth:	12 cm (2-21 cm)
Argiborolls, less often Lithic Argiborolls		Average Surface Coarse:	52% (40-66%)
Surface stony, gravelly, cobbly, often very much so		Average Bare Surface:	9% (1-16%)
Surface clay loams or loams		Average Tree Cover:	32% (15-63%)
Subsurface clays to sandy clays		Average Shrub Cover:	15% (3-29%)
Parent colluvial		Average Graminoid Cover:	41% (10-59%)
Moderately deep, less often shallow		Average Forb Cover:	3% (1-5%)
		Average Total Live Cover:	91.4% (51.7-117.5%)
		Average No. Species:	32 (25-47)

2. Ponderosa Pine Ecological Series (PIPO)

The ecological types in the Ponderosa Pine Series are **warmer** than those in the following Series (Bristlecone Pine).

FD02 – *Ponderosa pine/Arizona fescue–Eutroboralfs–Gentle slopes and mesas, 8,400-10,100 ft* (PIPO/FEAR2). The soil of this ecological type has **more clay** (especially in the subsurface) and a somewhat **moister** slope position, as compared with the next type (FD03).

No. Samples/L&G/S:	8/5/4	Average Elevation:	9,270 ft (8,460-10,060 ft)
Landforms and Geology:		Average Aspect:	178°M (r = 0.48)
Soil creep slopes, less often mesas		Average Slope:	14% (3-42%)
Footslopes and backslopes, less often summits		Average Coarse in Soil:	51% (29-67%)
Mostly linear		Average Soil Depth:	83 cm (60-143 cm)
Tertiary tuffs, basalts, breccias, and rhyolites		Average Mollic Depth:	11 cm (8-14 cm)
Soils:		Average Surface Coarse:	12% (7-19%)
Eutroboralfs (sometimes Mollic), less often Argiborolls		Average Bare Surface:	15% (1-52%)
Surface not coarse or gravelly, less often cobbly		Average Tree Cover:	42% (1-69%)
Surface clay loams, sandy loams, or loams		Average Shrub Cover:	12% (0-67%)
Subsurface clayier: **clays**, sandy **clay** loams, or **clay** loams		Average Graminoid Cover:	37% (12-57%)
Parent colluvial or less often residual		Average Forb Cover:	13% (2-32%)
Moderately deep to deep or very deep		Average Total Live Cover:	103.6% (48.0-138.2%)
		Average No. Species:	30 (24-38)

FD03 – *Ponderosa pine/bitterbrush–Moderately deep to shallow Haploborolls–Gentle convex mesas and ridges, 8,300-9,400 ft* (PIPO/PUTR2). The soil of this ecological type has **less clay** (especially in the subsurface) and a somewhat **drier** slope position, as compared with the previous type (FD03).

No. Samples/L&G/S:	11/6/5	Average Elevation:	8,969 ft (8,360-9,400 ft)
Landforms and Geology:		Average Aspect:	136°M (r = 0.38)
Mesas, ridges, or soil creep slopes		Average Slope:	19% (3-36%)
Shoulders and summits, less often footslopes or backslopes		Average Coarse in Soil:	53% (24-84%)
Convex or linear		Average Soil Depth:	58 cm (38-115 cm)
Tertiary tuffs and breccias, less often granites or gneisses		Average Mollic Depth:	19 cm (6-30 cm)
Soils:		Average Surface Coarse:	10% (1-33%)
Haploborolls (often Lithic), less often Lithic Ustorthents or Ustochrepts		Average Bare Surface:	5% (1-14%)
Surface not coarse, less often gravelly or cobbly		Average Tree Cover:	39% (10-56%)
Surface texture variable, often **sandy**		Average Shrub Cover:	29% (8-48%)
Subsurface **loamy sands or sandy loams**		Average Graminoid Cover:	40% (6-70%)
Parent colluvial, colluvial over residual, or residual		Average Forb Cover:	16% (2-50%)
Shallow or moderately deep, less often deep		Average Total Live Cover:	124.5% (62.0-177.0%)
		Average No. Species:	28 (12-47)

3. Bristlecone Pine Ecological Series (PIAR)

The ecological types in the Bristlecone Pine Series are **colder** than those in the preceding Ponderosa Pine Series (2), and **drier** than the several Fir-Spruce Series (5, 7, 8a), although elevations of all these overlap. The ecological types in this ecological series almost always occur on **moderate to steep, very well-drained** slopes.

FD04 – *Bristlecone pine/wax currant-Arizona fescue–Moderately deep to shallow colluvial **Cryic** soils–Southeasterly backslopes, 9,400-10,400 ft* (PIAR/RICE-FEAR2). This ecological type occurs at **lower elevations** and has **shallower** soils, as compared with the next type (FD05). Both of these factors probably relate to moisture availability: the lower elevations of this ecological type mean that it is in a deeper rainshadow, with lower precipitation, leading to shallower soils.

No. Samples/L&G/S:	8/6/3	**Average Elevation:**	**9,985 ft (9,440-10,380 ft)**
Landforms and Geology:		**Average Aspect:**	**143°M (r = 0.78)**
Soil creep slopes		Average Slope:	26% (9-51%)
Backslopes and upper backslopes		Average Coarse in Soil:	54% (35-68%)
Usually linear		Average Soil Depth:	71 cm (62-75 cm)
Tertiary rhyolites and welded tuffs		Average Mollic Depth:	9 cm (0-13 cm)
Soils:		Average Surface Coarse:	43% (10-90%)
Cryoborolls (sometimes Lithic), less often Cryochrepts or Cryorthents		Average Bare Surface:	14% (3-65%)
Surface gravelly, cobbly, stony, or all three		Average Tree Cover:	49% (21-66%)
Surface loams		Average Shrub Cover:	7% (2-20%)
Subsurface variable, usually loamy, sometimes broken rock		Average Graminoid Cover:	37% (25-62%)
Parent colluvial		Average Forb Cover:	14% (4-32%)
Moderately deep to shallow		Average Total Live Cover:	107.2% (80.9-154.4%)
		Average No. Species:	26 (20-32)

FD05 – *Bristlecone pine/Thurber fescue–Cryic soils–Subalpine slopes, > 11,000 ft* (PIAR/FETH). This ecological type occurs at **higher elevations** and has **deeper** soils, as compared with the previous type (FD04). Both of these factors probably relate to moisture availability: the higher elevations of this ecological type mean that it is outside (or above) rainshadows, with greater precipitation, leading to deeper soils.

No. Samples/L&G/S:	2/3/1	**Average Elevation:**	**11,190 ft (10,520-11,860 ft)**
Landforms and Geology:		Average Aspect:	(no data)
Soil creep slopes		Average Slope:	35% (21-48%)
Backslopes		Average Coarse in Soil:	66%
Linear to convex		Average Soil Depth:	81 cm
Tertiary tuffs or breccias, less often granites		Average Mollic Depth:	25 cm
Soils:		Average Surface Coarse:	9% (2-16%)
Cryoborolls, less often Cryochrepts		Average Bare Surface:	3% (1-6%)
Surface cobbly, gravelly-cobbly, or not coarse		Average Tree Cover:	64% (55-73%)
Surface sandy or loamy		Average Shrub Cover:	4% (4-5%)
Subsurface sandy or clayey		Average Graminoid Cover:	75% (24-126%)
Parent colluvial		Average Forb Cover:	17% (6-29%)
Deep to moderately deep		Average Total Live Cover:	161.0% (112.9-209.1%)
		Average No. Species:	36 (28-43)

4. Douglas-Fir Ecological Series (PSME)

The Douglas-Fir Ecological Series is generally **moister** than any of the pine series (2, 3, 6), and **warmer** than the Subalpine Fir-Engelmann Spruce Series (8). The eight ecological types in this Series are very distinct from one another on vegetation grounds, but often overlap in vegetation and soils. They seem to fall into three groups based on average aspect (Fig. 3-3), and three groups based on average coarseness of soil (Fig. 3-4).

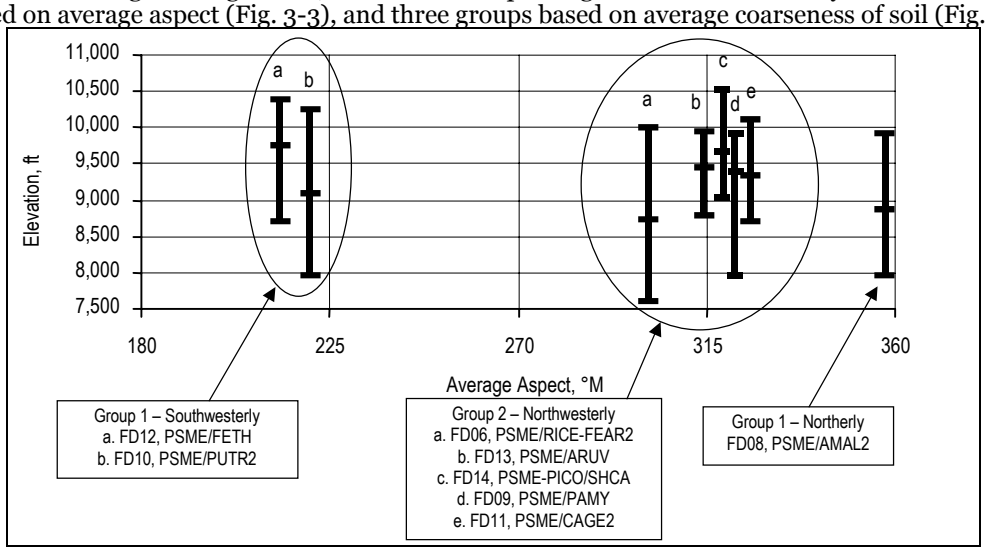

Fig. 3-3. Elevation versus average aspect for the eight ecological types in the Douglas-fir Ecological Series.

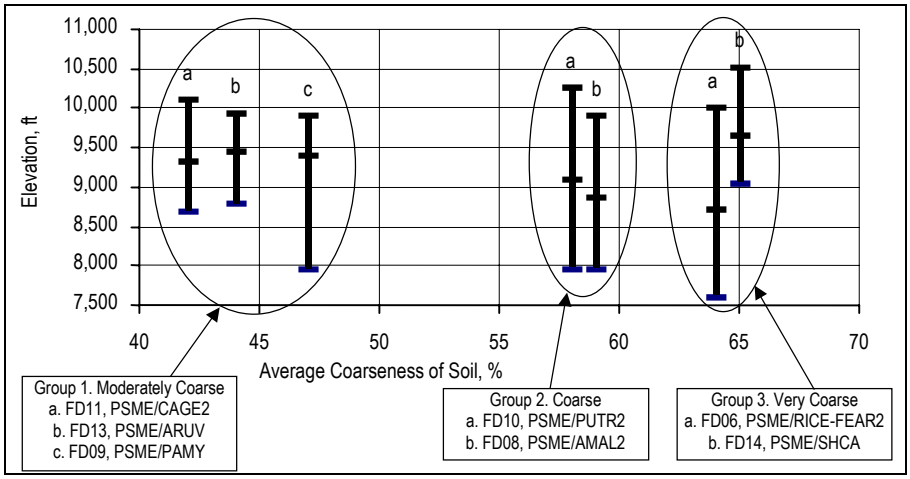

Fig. 3-4. Elevation versus average coarseness for seven of the ecological types in the Douglas-fir Ecological Series. Soils were not measured for FD12, PSME/FETH, but it is likely in the moderately coarse group.

FD06 – *Douglas-fir/wax currant-Arizona fescue–Gravelly or cobbly barely-Mollic Eutroboralfs or Argiborolls–**Steep slopes**, 7,600-10,000 ft* (PSME/RICE-FEAR2). This ecological type is the **driest** and **warmest** type in the Douglas-Fir Series, and also occurs at some of the lowest elevations for the Series.

No. Samples/L&G/S:	31/10/9
Landforms and Geology:	
Soil creep slopes	
Backslopes, less often upper backslopes	
Usually linear	
Tertiary tuffs, rhyolites, or breccias; less often schists, granites or gneisses; less often Cretaceous sandstones	
Soils:	
Eutroboralfs or Argiborolls, less often Ustochrepts	
Surface cobbly or gravelly (sometimes very much so), less often stony	
Surface texture variable, often sandy or silty	
Subsurface variable, usually clayier than surface	
Parent colluvial, less often colluvial over residual	
Moderately deep to very deep, rarely very deep	

Average Elevation:	**8,729 ft (7,600-10,000 ft)**
Average Aspect:	301°M (r = 0.33)
Average Slope:	39% (14-100%)
Average Coarse in Soil:	64% (28-90%)
Average Soil Depth:	49 cm (8-124 cm)
Average Mollic Depth:	13 cm (3-26 cm)
Average Surface Coarse:	27% (4-72%)
Average Bare Surface:	8% (0-60%)
Average Tree Cover:	48% (20-75%)
Average Shrub Cover:	19% (0-81%)
Average Graminoid Cover:	22% (0-115%)
Average Forb Cover:	7% (0-71%)
Average Total Live Cover:	96.0% (37.4-268.8%)
Average No. Species:	25 (13-40)

FD08 – *Douglas-fir/serviceberry–Thin-dark Frigid soils–Steep* ***northerly*** *backslopes or shoulders, 7,900-10,000 ft* (PSME/AMAL2).

No. Samples/L&G/S:	35/10/9	Deep to moderately deep	
Landforms and Geology:		Average Elevation:	8,875 ft (7,960-9,920 ft)
Soil creep slopes		Average Aspect:	357°M (r = 0.64)
Backslopes or upper backslopes, rarely shoulders		Average Slope:	37% (8-66%)
Linear to concave		Average Coarse in Soil:	59% (22-85%)
Tertiary tuffs (sometimes welded) or breccias, less often Granites or Gneisses		Average Soil Depth:	69 cm (33-180 cm)
Soils:		Average Mollic Depth:	15 cm (0-48 cm)
Haploborolls or Glossoboralfs-Eutroboralfs, less often Ustochrepts, rarely Argiborolls		Average Surface Coarse:	14% (0-80%)
Surface usually not coarse, less often gravelly or cobbly, rarely stony		Average Bare Surface:	5% (0-15%)
Surface texture variable		Average Tree Cover:	80% (14-211%)
Subsurface variable		Average Shrub Cover:	58% (3-165%)
Parent usually colluvial, less often colluvial over residual or old alluvial		Average Graminoid Cover:	65% (0-166%)
		Average Forb Cover:	41% (0-185%)
		Average Total Live Cover:	243.7% (68.2-491.5%)
		Average No. Species:	25 (12-51)

FD09 – *Douglas-fir/pachistima–Dark Frigid soils–****Northerly*** *backslopes, 7,900-10,000 ft* (PSME/PAMY)

No. Samples/L&G/S:	34/7/7	Average Elevation:	9,391 ft (7,960-9,920 ft)
Landforms and Geology:		Average Aspect:	320°M (r = 0.70)
Soil creep slopes		Average Slope:	32% (13-52%)
Backslopes or upper backslopes		Average Coarse in Soil:	47% (13-75%)
Linear		Average Soil Depth:	70 cm (46-104 cm)
gneisses or granites, less often Tertiary tuffs or schists, less often Cretaceous-Jurassic sandstone or siltstones		Average Mollic Depth:	15 cm (5-33 cm)
Soils:		Average Surface Coarse:	4% (0-80%)
Eutroboralfs, Argiborolls, or Cryochrepts		Average Bare Surface:	1% (0-15%)
Surface usually not coarse, rarely stony		Average Tree Cover:	79% (37-120%)
Surface loams, sandy loams, or sandy clay loams		Average Shrub Cover:	62% (10-135%)
Subsurface variable, almost always sandy or sand		Average Graminoid Cover:	48% (1-111%)
Parent colluvial, rarely old alluvial		Average Forb Cover:	38% (0-125%)
Deep to moderately deep		Average Total Live Cover:	227.0% (107.0-412.5%)
		Average No. Species:	18 (8-29)

FD10 – *Douglas-fir/bitterbrush–Thin-dark Frigid soils–Gentle slopes, 7,900-10,300 ft* (PSME/PUTR2)

No. Samples/L&G/S:	41/5/5	Average Elevation:	9,097 ft (7,960-10,260 ft)
Landforms and Geology:		Average Aspect:	220°M (r = 0.38)
Soil creep slopes or ridges, less often mesas		Average Slope:	27% (3-100%)
Backslopes, shoulders, or summits		Average Coarse in Soil:	58% (24-84%)
Convex to linear, sometimes undulating		Average Soil Depth:	65 cm (40-152 cm)
Granites or Tertiary tuffs, less often Cretaceous sandstones or shales, or gneiss		Average Mollic Depth:	10 cm (0-30 cm)
Soils:		Average Surface Coarse:	14% (0-80%)
Variable: Eutroboralfs, Haploborolls, Haplochrepts, or Argiborolls		Average Bare Surface:	4% (0-18%)
Surface texture variable: either not coarse, stony, or cobbly, less often gravelly		Average Tree Cover:	48% (16-100%)
Surface texture variable		Average Shrub Cover:	39% (11-85%)
Subsurface variable		Average Graminoid Cover:	44% (0-150%)
Parent colluvial, less often residual		Average Forb Cover:	14% (0-72%)
Depth variable		Average Total Live Cover:	145.0% (67.2-319.5%)
		Average No. Species:	22 (12-38)

FD11 – *Douglas-fir/elk sedge–Dark Frigid or Cryic soils–Gentle to steep slopes, 8,700-10,200 ft* (PSME/CAGE2)

No. Samples/L&G/S:	50/8/8	Average Elevation:	9,337 ft (8,700-10,120 ft)
Landforms and Geology:		Average Aspect:	325°M (r = 0.23)
Soil creep slopes		Average Slope:	30% (13-66%)
Backslopes, less often upper backslopes		Average Coarse in Soil:	42% (9-85%)
Mostly linear		Average Soil Depth:	62 cm (33-155 cm)
gneisses, schists, or granites, less often Cretaceous sandstones, less often Tertiary tuffs		Average Mollic Depth:	17 cm (1-52 cm)
Soils:		Average Surface Coarse:	5% (0-24%)
Cryoborolls or Eutroboralfs, less often Glossoboralfs, Haploborolls, or Argiborolls		Average Bare Surface:	3% (0-18%)
Surface not coarse, less often cobbly or gravelly		Average Tree Cover:	68% (28-118%)
Surface texture variable, sometimes organic		Average Shrub Cover:	30% (2-121%)
Subsurface variable		Average Graminoid Cover:	58% (6-146%)
Parent colluvial, rarely old-alluvial		Average Forb Cover:	40% (1-201%)
Deep to moderately deep to very deep		Average Total Live Cover:	196.3% (66.0-448.5%)
		Average No. Species:	18 (5-42)

FD12 – *Douglas-fir/Thurber fescue–Dark Cryic soils–Gentle slopes, 8,700-10,400 ft* (PSME/FETH)

No. Samples/L&G/S:	60/6/0	Average Elevation:	9,752 ft (8,700-10,400 ft)
Landforms and Geology:		Average Aspect:	213°M (r = 0.59)
Soil creep slopes, less often slump-earthflows or ridges		Average Slope:	22% (10-40%)
Backslopes, less often upper backslopes or footslopes		Average Coarse in Soil:	
Undulating, linear, or concave		Average Soil Depth:	
Cretaceous or Jurassic shales, sandstones, and siltstones; less often Gneisses		Average Mollic Depth:	
		Average Surface Coarse:	3% (0-24%)
Soils:		Average Bare Surface:	4% (0-18%)
Cryoborolls or Argiborolls		Average Tree Cover:	71% (23-131%)
Surface not coarse		Average Shrub Cover:	61% (10-140%)
Surface texture unknown		Average Graminoid Cover:	117% (50-200%)
Subsurface texture unknown		Average Forb Cover:	81% (17-240%)
Parent colluvial, less often residual		Average Total Live Cover:	330.1% (170.0-592.5%)
Depth unknown		Average No. Species:	17 (11-44)

FD13 – *Douglas-fir/kinnikinnick–Thin-dark Frigid or Cryic soils–Gentle slopes, 8,800-10,000 ft* (PSME/ARUV)

No. Samples/L&G/S:	49/7/7	Average Elevation:	9,458 ft (8,800-9,940 ft)
Landforms and Geology:		Average Aspect:	314°M (r = 0.32)
Soil creep slopes, less often ridges or moraines		Average Slope:	19% (2-39%)
Backslopes, upper backslopes, and summits, less often shoulders		Average Coarse in Soil:	44% (33-61%)
		Average Soil Depth:	56 cm (41-75 cm)
Linear to convex, less often undulating		Average Mollic Depth:	11 cm (5-19 cm)
Geology variable		Average Surface Coarse:	1% (0-5%)
Soils:		Average Bare Surface:	0% (0-2%)
Eutroboralfs, less often Haploborolls, Argiborolls, or Haplochrepts		Average Tree Cover:	63% (26-120%)
		Average Shrub Cover:	47% (14-160%)
Surface not coarse, less often stony or cobbly		Average Graminoid Cover:	47% (1-151%)
Surface texture variable, sometimes clayey		Average Forb Cover:	25% (0-210%)
Subsurface variable, sometimes sandy		Average Total Live Cover:	182.0% (55.0-473.0%)
Parent colluvial, less often residual or glacial		Average No. Species:	15 (4-35)
Deep, less often moderately deep			

FD14 – *Douglas-fir-lodgepole pine/buffaloberry–Sandy Cryochrepts–Gentle to steep* ***northerly*** *slopes, 9,000-10,600 ft* (PSME/SHCA)

No. Samples/L&G/S:	26/5/5	Average Elevation:	9,666 ft (9,050-10,520 ft)
Landforms and Geology:		**Average Aspect:**	**320°M (r = 0.66)**
Soil creep slopes		Average Slope:	38% (24-49%)
Backslopes, less often upper backslopes		Average Coarse in Soil:	65% (28-85%)
Mostly linear		Average Soil Depth:	88 cm (50-175 cm)
Granites, less often Permian sandstones or shales		Average Mollic Depth:	6 cm (3-9 cm)
Soils:		Average Surface Coarse:	4% (0-11%)
Cryochrepts, less often Cryoboralfs		Average Bare Surface:	1% (0-2%)
Surface not coarse, rarely stony		Average Tree Cover:	74% (26-140%)
Surface sandy loams or sandy clay loams, sometimes organic or loams		Average Shrub Cover:	67% (16-140%)
		Average Graminoid Cover:	18% (0-65%)
Subsurface loamy sands or sandy loams, less often sandy clay loams or sandy clays		Average Forb Cover:	18% (0-76%)
		Average Total Live Cover:	176.5% (97.0-321.5%)
Parent colluvial		Average No. Species:	15 (9-27)
Moderately deep to deep, less often very deep			

5. Blue Spruce Uplands Ecological Series (PIPU)

Even though blue spruce is a moisture-loving tree, the stands in this Series in the UGB have dry to very dry soil surfaces. However, the soil subsurfaces are much moister, due to throughflow of moisture just above the **Argillic horizon**, from snowmelt upslope on these mountains. In the UGB, this Series occurs in deep rainshadow climates.

FD15 – *Blue spruce/Arizona fescue open forest–Argiborolls–Gentle to steep **easterly** slopes and benches, 9,200-10,200 ft* (PIPU/FEAR2).

No. Samples/L&G/S:	6/4/2	Average Elevation:	9,838 ft (9,280-10,140 ft)
Landforms and Geology:		**Average Aspect:**	**73°M (r = 0.52)**
Soil creep slopes, less often benches		Average Slope:	27% (5-70%)
Backslopes, less often footslopes		Average Coarse in Soil:	53% (47-58%)
Linear, less often undulating or convex		Average Soil Depth:	42 cm (32-52 cm)
Tertiary tuffs, usually welded		Average Mollic Depth:	14 cm (2-26 cm)
Soils:		Average Surface Coarse:	20% (0-70%)
Argiborolls, less often Cryoboralfs		Average Bare Surface:	7% (0-30%)
Surface not coarse, sometimes gravelly or gravelly-cobbly-stony		Average Tree Cover:	70% (25-112%)
		Average Shrub Cover:	13% (0-41%)
Surface texture various		Average Graminoid Cover:	49% (25-86%)
Subsurface various		Average Forb Cover:	21% (7-63%)
Parent colluvial		Average Total Live Cover:	152.9% (84.4-284.5%)
Depth variable		Average No. Species:	23 (19-28)

FD16 – *Blue spruce-Engelmann spruce/kinnikinnick–Cryoboralfs or Eutroboralfs–Gentle **northerly** slopes, 9,400-10,500 ft* (PIPU-PIEN/ARUV).

No. Samples/L&G/S:	6/5/5	Average Elevation:	9,800 ft (9,400-10,480 ft)
Landforms and Geology:		**Average Aspect:**	**336°M (r = 0.58)**
Soil creep slopes, less often slump-earthflows		Average Slope:	15% (9-24%)
Backslopes, less often footslopes or toeslopes		Average Coarse in Soil:	51% (29-65%)
Mostly linear		Average Soil Depth:	58 cm (47-73 cm)
Tertiary tuffs, breccias, rhyolites, and andesites		Average Mollic Depth:	7 cm (0-12 cm)
Soils:		Average Surface Coarse:	3% (0-12%)
Cryoboralfs, less often Eutroboralfs or Ustochrepts		Average Bare Surface:	3% (0-15%)
Surface not coarse, less often gravelly		Average Tree Cover:	88% (61-123%)
Surface loams, sandy loams, or sandy clay loams		Average Shrub Cover:	28% (10-56%)
Subsurface clayier than surface		Average Graminoid Cover:	27% (1-90%)
Parent colluvial or colluvial over residual		Average Forb Cover:	14% (1-23%)
Deep to moderately deep		Average Total Live Cover:	157.5% (101.1-270.6%)
		Average No. Species:	28 (24-39)

6. Lodgepole Pine Ecological Series (PICO)

The ecological types in this Series occur on **dry to very dry** sites, usually as a combination of low precipitation (often from rainshadows), and **well-drained** soils. These sites are too dry to support spruce or fir.

FD17 – *Lodgepole pine/silvertop sedge–Cold Cryoboralfs–Glacial granitic slopes, 9,900-10,800 ft* (PICO/CAFO3). This ecological type is often adjacent or near by stands of the next type (FD18), with this type on slopes below FD18. It is found more often on the somewhat warmer and drier slopes.

No. Samples/L&G/S:	3/8/1	Average Elevation:	10,197 ft (9,930-10,730 ft)
Landforms and Geology:		Average Aspect:	58°M (r = 0.34)
Glacial outwashes or moraines		Average Slope:	21% (16-29%)
Backslopes		Average Coarse in Soil:	23% (16-30%)
Usually undulating		Average Soil Depth:	106 cm (71-124 cm)
Granites		Average Mollic Depth:	6 cm (2-15 cm)
Soils:		Average Surface Coarse:	1% (0-2%)
Cryoboralfs, less often Cryochrepts		Average Bare Surface:	12% (0-35%)
Surface not coarse		Average Tree Cover:	65% (22-91%)
Surface texture unknown		Average Shrub Cover:	1% (0-2%)
Subsurface texture unknown		Average Graminoid Cover:	38% (5-73%)
Parent usually glacial		Average Forb Cover:	9% (0-26%)
Deep		Average Total Live Cover:	112.5% (86.9-128.1%)
		Average No. Species:	22 (14-32)

FD18 – *Lodgepole pine/Rocky Mountain whortleberry–Cryoboralfs–Gentle to moderately steep slopes, 9,300-10,600 ft* (PICO/VAMYO). This ecological type is often adjacent or near by stands of the previous type (FD17), with this type on slopes above FD17. It is found more often on the colder, moister north slopes.

No. Samples/L&G/S:	13/3/2	Average Elevation:	10,063 ft (9,350-10,600 ft)
Landforms and Geology:		Average Aspect:	52°M (r = 0.31)
Soil creep slopes, less often mesas		Average Slope:	15% (5-29%)
Backslopes or shoulders		Average Coarse in Soil:	49% (39-60%)
Linear or convex		Average Soil Depth:	159 cm (43-275 cm)
Geology variable		Average Mollic Depth:	5 cm (0-10 cm)
Soils:		Average Surface Coarse:	1% (0-2%)
Cryoboralfs, sometimes Lithic or Mollic		Average Bare Surface:	1% (0-2%)
Surface not coarse		Average Tree Cover:	75% (40-107%)
Surface texture variable		Average Shrub Cover:	61% (26-116%)
Subsurface variable		Average Graminoid Cover:	19% (0-61%)
Parent colluvial or residual		Average Forb Cover:	25% (1-62%)
Depth variable		Average Total Live Cover:	179.2% (96.0-278.0%)
		Average No. Species:	13 (5-25)

FD19 – *Lodgepole pine/sparse–Cryoboralfs-Slopes* (PICO/sparse). This ecological type typically occurs on the youngest glacial deposits, **extremely well-drained**.

No. Samples/L&G/S:	8/0/0	Average Elevation:	10,063 ft (9,350-10,600 ft)
Landforms and Geology:		Average Aspect:	
		Average Slope:	
Soils:		Average Coarse in Soil:	
		Average Soil Depth:	
		Average Mollic Depth:	
		Average Surface Coarse:	
		Average Bare Surface:	1% (0-2%)
		Average Tree Cover:	48% (30-60%)
		Average Shrub Cover:	11% (2-26%)
		Average Graminoid Cover:	1% (0-5%)
		Average Forb Cover:	4% (1-15%)
		Average Total Live Cover:	63.6% (46.0-81.0%)
		Average No. Species:	7 (4-11)

B. Moderately-Moist Forests (FL)

7. Subalpine Fir-Douglas-Fir Ecological Series (ABBI2-PSME)

FL01 – *Subalpine fir-Douglas-fir/pachistima–Thin-dark Cryoboralfs and Cryoborolls–Moderately steep slopes, 9,300-10,300 ft* (ABBI2-PSME/PAMY). This ecological type is somewhat **warmer** and **drier** than the following type (FL02).

No. Samples/L&G/S:	10/5/5	Average Elevation:	9,824 ft (9,320-10,235 ft)
Landforms and Geology:		Average Aspect:	251°M (r = 0.36)
Soil creep slopes		Average Slope:	22% (16-38%)
Backslopes, less often lower backslopes		Average Coarse in Soil:	55% (25-77%)
Usually linear		Average Soil Depth:	81 cm (59-101 cm)
Granites or gneisses of various ages, less often Jurassic-		Average Mollic Depth:	15 cm (3-33 cm)
Cretaceous sandstone, siltstones, or shales		Average Surface Coarse:	2% (0-7%)
Soils:		Average Bare Surface:	0% (0-0%)
Cryoboralfs, less often Argic Cryoborolls		Average Tree Cover:	106% (80-158%)
Surface not coarse		Average Shrub Cover:	62% (4-126%)
Surface texture various		Average Graminoid Cover:	63% (0-111%)
Subsurface various		Average Forb Cover:	48% (1-114%)
Parent colluvial, less often old-alluvial		Average Total Live Cover:	279.0% (197.0-409.5%)
Deep, less often very deep		Average No. Species:	21 (12-31)

FL02 – *Subalpine fir/twinflower–Cryochrepts and Cryoboralfs–Steep northerly slopes, 9,100-10,100 ft* (ABBI2/LIBO3). This ecological type is somewhat **cooler** and **moister** than the preceding type (FL01).

No. Samples/L&G/S:	8/4/4	**Average Aspect:**	**351°M (r = 0.79)**
Landforms and Geology:		**Average Slope:**	**50% (45-60%)**
Soil creep slopes, less often periglacial		Average Coarse in Soil:	63% (56-73%)
Backslopes		Average Soil Depth:	75 cm (61-84 cm)
Undulating to linear		Average Mollic Depth:	13 cm (0-42 cm)
Tertiary granites, tuffs, and rhyolites		Average Surface Coarse:	4% (0-10%)
Soils:		Average Bare Surface:	0% (0-1%)
Cryochrepts, less often Cryoboralfs or Argiborolls		Average Tree Cover:	94% (67-110%)
Surface not coarse, or less often gravelly		Average Shrub Cover:	64% (11-106%)
Surface clay loams or sandy clay loams, less often loams		Average Graminoid Cover:	12% (0-51%)
Subsurface variable, often sandy		Average Forb Cover:	43% (4-72%)
Parent colluvial		Average Total Live Cover:	212.6% (141.1-272.5%)
Moderately deep to deep		Average No. Species:	21 (12-30)
Average Elevation:	9,775 ft (9,160-10,020 ft)		

8a. Subalpine Fir-Engelmann Spruce Ecological Series (Tall Forests) (ABBI2-PIEN)

Ecological types in this Series typically occur between about 10,000 ft (3,050 m) and timberline on stable slopes and rounded summits, wherever there is sufficient moisture and adequate drainage for conifer tree growth. Ecological types FL05 and FL09 are the indicated "climatic climaxes" for the lower and upper **Subalpine**, respectively. Geology is not at all diagnostic or determinative of ecological type in this Series. Soils are most often Cryoboralfs, with a light-colored "ashy" layer immediately below the dark, decomposed litter – this "ashy" layer is depleted in clay and iron oxides, and usually contains an abundance of mycorrhizal fungi symbiotic with the roots one or more of the tree species. Sometimes the soils might be Cryochrepts, on slopes so steep that soil creep interferes with litter accumulation and soil development.

FL03 – *Subalpine fir-Engelmann spruce/pachistima–Cryoboralfs–Slopes, 9,800-10,900 ft* (ABBI2-PIEN/PAMY)

No. Samples/L&G/S:	9/5/4	Average Aspect:	352°M (r = 0.30)
Landforms and Geology:		Average Slope:	25% (3-40%)
Soil creep slopes, less often moraines		Average Coarse in Soil:	66% (56-77%)
Backslopes		Average Soil Depth:	76 cm (57-111 cm)
Mostly linear		Average Mollic Depth:	6 cm (4-9 cm)
Granites or Permian sandstones, less often Tertiary tuffs		Average Surface Coarse:	6% (0-10%)
Soils:		Average Bare Surface:	0% (0-2%)
Cryoboralfs		Average Tree Cover:	111% (71-200%)
Surface not coarse		Average Shrub Cover:	53% (7-86%)
Surface texture various, often clayey		Average Graminoid Cover:	38% (0-140%)
Subsurface various, often clayey		Average Forb Cover:	37% (1-160%)
Parent colluvial, less often glacial		Average Total Live Cover:	238.7% (135.0-451.5%)
Deep		Average No. Species:	18 (9-27)
Average Elevation:	10,312 ft (9,840-10,860 ft)		

FL04 – Minor spruce-fir types

FL04A – *Engelmann spruce-aspen/Thurber fescue-timber oatgrass–Cryoboralfs–Gentle backslopes* (POTR5-PIEN-DAIN-FETH).

No. Samples/L&G/S:	2/1/1	Average Elevation:	10,400 ft
Landforms and Geology:		Average Aspect:	East
Moraines		Average Slope:	7%
Footslopes		Average Coarse in Soil:	59% (56-61%)
Undulating		Average Soil Depth:	68 cm (60-75 cm)
Tertiary granites		Average Mollic Depth:	5 cm
Soils:		Average Surface Coarse:	2% (1-3%)
Cryoboralfs		Average Bare Surface:	12% (8-15%)
Surface not coarse		Average Tree Cover:	85% (80-90%)
Surface texture unknown		Average Shrub Cover:	5% (3-6%)
Subsurface texture unknown		Average Graminoid Cover:	87% (82-92%)
Parent glacial		Average Forb Cover:	18% (14-21%)
Deep		Average Total Live Cover:	195% (190-199%)
		Average No. Species:	32 (31-32)

FL04B – *Subalpine fir-Engelmann spruce/dwarf bilberry–Sandy Cryoboralfs–Gentle granitic glacial slopes* (PICO-PIEN-VACE).

No. Samples/L&G/S:	2/2/0	Average Elevation:	10,240 ft
Landforms and Geology:		Average Aspect:	089°M
Soil creep slopes		Average Slope:	12%
Backslopes and lower backslopes		Average Coarse in Soil:	52%
Linear to convex		Average Soil Depth:	82 cm
Tertiary breccias and welded tuffs		Average Mollic Depth:	5 cm
Soils:		Average Surface Coarse:	2%
Cryoboralfs and Cryochrepts		Average Bare Surface:	0%
Surface not coarse		Average Tree Cover:	73%
Surface texture unknown		Average Shrub Cover:	34%
Subsurface texture unknown		Average Graminoid Cover:	3%
Parent colluvial		Average Forb Cover:	5%
Depth unknown		Average Total Live Cover:	115%
		Average No. Species:	22

FL05 – *Subalpine fir-Engelmann spruce/elk sedge–Cryoboralfs, clayey–Gentle slopes, 10,000-10,700* (ABBI2-PIEN/CAGE2). This ecological type is typically on slopes that are **not northerly**. This ecological type is the indicated climatic climax on somewhat **warmer** lower **Subalpine** slopes.

No. Samples/L&G/S:	31/5/5	Average Elevation:	10,377 ft (10,020-10,670 ft)
Landforms and Geology:		**Average Aspect:**	**200°M (r = 0.54)**
Soil creep slopes, less often mesas		Average Slope:	15% (0-34%)
Backslopes, less often shoulders or summits		Average Coarse in Soil:	64% (31-81%)
Linear or less often convex		Average Soil Depth:	67 cm (30-116 cm)
Tertiary basalts or sandstones, limestones, and shales of various ages		Average Mollic Depth:	18 cm (1-65 cm)
		Average Surface Coarse:	2% (0-10%)
Soils:		Average Bare Surface:	2% (0-25%)
Cryoboralfs, less often Argic Cryoborolls		Average Tree Cover:	112% (40-300%)
Surface not coarse		Average Shrub Cover:	20% (0-81%)
Surface texture various, often clayey		Average Graminoid Cover:	75% (19-185%)
Subsurface clays, silty clays, and sandy clays		Average Forb Cover:	55% (2-235%)
Parent colluvial, less often colluvial over residual or residual		Average Total Live Cover:	262.0% (139.5-525.0%)
Deep to moderately deep		Average No. Species:	19 (12-40)

FL06 – *Subalpine fir-Engelmann spruce/moss–Cryoboralfs–Gentle to steep **northerly** slopes, 9,700-11,100 ft* (ABBI2-PIEN/moss). This ecological type is **cold** and **wet** when compared with other fir-spruce types.

No. Samples/L&G/S:	13/5/5	Average Elevation:	10,389 ft (9,700-11,050 ft)
Landforms and Geology:		**Average Aspect:**	**27°M (r = 0.63)**
Soil creep slopes and lateral moraines, less often benches or slump-earthflows		Average Slope:	15% (3-64%)
		Average Coarse in Soil:	56% (33-82%)
Backslopes, less often footslopes or summits		Average Soil Depth:	74 cm (42-115 cm)
Usually linear		Average Mollic Depth:	11 cm (2-20 cm)
Geology various		Average Surface Coarse:	3% (0-8%)
Soils:		Average Bare Surface:	5% (0-25%)
Cryoboralfs, less often Cryochrepts		Average Tree Cover:	101% (63-200%)
Surface not coarse		Average Shrub Cover:	6% (0-25%)
Surface clay loams or sandy clay loams, less often loams		Average Graminoid Cover:	5% (0-16%)
Subsurface variable, usually clayey		Average Forb Cover:	17% (0-94%)
Parent colluvial or glacial		Average Total Live Cover:	129.6% (63.4-214.0%)
Deep, less often very deep or moderately deep		Average No. Species:	23 (11-34)

FL07 – *Subalpine fir-Engelmann spruce/buffaloberry–Cryochrepts–Slopes, >10,000 ft* (ABBI2-PIEN/SHCA).

No. Samples/L&G/S:	12/2/1	Average Elevation:	10,100 ft
Landforms and Geology:		Average Aspect:	27°M (r = 0.63)
Lateral moraines		Average Slope:	22% (21-23%)
Footslopes		Average Coarse in Soil:	53% (28-77%)
Undulating		Average Soil Depth:	45 cm
Granites and schists		Average Mollic Depth:	6 cm
Soils:		Average Surface Coarse:	17% (14-20%)
Cryochrepts		Average Bare Surface:	0% (0-0%)
Surface stony		Average Tree Cover:	71% (37-92%)
Surface sandy		Average Shrub Cover:	93% (45-145%)
Subsurface sandy		Average Graminoid Cover:	10% (0-30%)
Parent glacial		Average Forb Cover:	23% (2-70%)
Moderately deep		Average Total Live Cover:	196.2% (141.7-264.0%)
		Average No. Species:	13 (9-20)

FL08 – *Engelmann spruce/mountain gooseberry–Cold Cryic soils–Gentle upper-Subalpine slopes, 10,100-12,200 ft* (PIEN/RIMO2). This ecological type is **cold** and **dry** – too dry for much subalpine fir (ABBI2) growth.

No. Samples/L&G/S:	7/6/2	Average Elevation:	11,182 ft (10,160-12,125 ft)
Landforms and Geology:		Average Aspect:	137°M (r = 0.44)
Soil creep slopes, less often ravines, mesas, or cirques		Average Slope:	14% (4-31%)
Backslopes, less often summits or footslopes		Average Coarse in Soil:	57% (51-62%)
Usually linear		Average Soil Depth:	50 cm (25-64 cm)
Tertiary or granites or breccias, less often Cretaceous shales		Average Mollic Depth:	12 cm (0-25 cm)
Soils:		Average Surface Coarse:	8% (0-18%)
Cryoboralfs, less often Cryorthents or Cryochrepts		Average Bare Surface:	4% (0-12%)
Surface not coarse, or sometimes gravelly-cobbly-stony		Average Tree Cover:	73% (33-107%)
Surface clay loams or silt loams		Average Shrub Cover:	28% (8-50%)
Subsurface sandy clay loams, sandy loams, or clay loams		Average Graminoid Cover:	43% (2-186%)
Parent colluvial, less often residual		Average Forb Cover:	47% (11-120%)
Deep to moderately deep		Average Total Live Cover:	190.9% (121.0-365.5%)
		Average No. Species:	22 (10-30)

FL09 – Subalpine fir-Engelmann spruce/Rocky Mountain whortleberry–Cryochrepts and Cryoboralfs–Moderate slopes, 10,600-11,400 ft (ABBI2-PIEN/VAMYO). This ecological type is the indicated climatic climax on cold upper **Subalpine** slopes.

No. Samples/L&G/S:	16/6/2	Average Elevation:	10,951 ft (10,600-11,385 ft)
Landforms and Geology:		Average Aspect:	204°M (r = 0.12)
Soil creep slopes, less often ridges		Average Slope:	14% (3-29%)
Backslopes, shoulders, or summits		Average Coarse in Soil:	67% (54-79%)
Linear or convex		Average Soil Depth:	42 cm (31-59 cm)
Geology various		Average Mollic Depth:	2 cm (0-7 cm)
Soils:		Average Surface Coarse:	0% (0-1%)
Cryochrepts or Cryoboralfs, less often Cryorthents		Average Bare Surface:	3% (0-10%)
Surface not coarse, less often gravelly-cobbly-stony		Average Tree Cover:	73% (32-116%)
Surface texture various		Average Shrub Cover:	55% (10-116%)
Subsurface various, often sandy		Average Graminoid Cover:	42% (1-100%)
Parent colluvial, less often residual		Average Forb Cover:	41% (0-105%)
Moderately deep		Average Total Live Cover:	210.4% (99.3-375.5%)
		Average No. Species:	16 (9-31)

8b. Subalpine Fir-Engelmann Spruce Ecological Series (Krummholz, Wind Deformed, Alpine Ecotone Forests) (ABBI2-PIEN)

FL10 – *Subalpine fir-Engelmann spruce/grayleaf willow Krummholz forest–Cryorthents–**Treeline wind-scarred** slopes, 11,600-12,000 ft* (ABBI2-PIEN/SAGL).

No. Samples/L&G/S:	2/2/1	Average Elevation:	11,670 ft (11,620-11,720 ft)
Landforms and Geology:		Average Aspect:	204°M (r = 0.12)
Benches, soil creep slopes, and cirques		Average Slope:	18% (18-19%)
Slope position various, usually above backslopes		Average Coarse in Soil:	0% (70-70%)
Slope shape various		Average Soil Depth:	34 cm (15-53 cm)
Geology various		Average Mollic Depth:	9 cm (0-17 cm)
Soils:		Average Surface Coarse:	22% (14-30%)
Cryorthents		Average Bare Surface:	3% (1-5%)
Surface cobbly or gravelly-cobbly-stony		Average Tree Cover:	29% (25-32%)
Surface texture various		Average Shrub Cover:	93% (78-109%)
Subsurface various		Average Graminoid Cover:	10% (4-16%)
Parent colluvial or residual		Average Forb Cover:	31% (9-53%)
Depth unknown		Average Total Live Cover:	164.6% (118.8-210.4%)
		Average No. Species:	36 (24-47)

9. Limber Pine Ecological Series (PIFL2)

FL11 – *Limber pine/common juniper–Very shallow soils–Rocky bouldery convex ridges and rockslides, >9,000 ft* (PIFL2/JUCO6). This ecological type is very exposed to wind, and so has no snow accumulation. It typically occurs on steep to very steep slopes.

No. Samples/L&G/S:	2/2/1	Average Elevation:	9,390 ft (9,000-9,780 ft)
Landforms and Geology:		Average Aspect:	204°M (r = 0.12)
Ridges, soil creep slopes, or rockslides		**Average Slope:**	**38% (22-53%)**
Backslopes		Average Coarse in Soil:	79%
Convex, less often linear		Average Soil Depth:	28 cm
Granites		Average Mollic Depth:	10 cm
Soils:		Average Surface Coarse:	36% (20-53%)
Lithic Eutroboralfs or Cryorthents		Average Bare Surface:	6% (1-10%)
Surface **extremely bouldery or extremely gravelly-cobbly-stony**		Average Tree Cover:	36% (27-45%)
Surface texture unknown		Average Shrub Cover:	9% (2-16%)
Subsurface texture unknown		Average Graminoid Cover:	8% (0-16%)
Parent residual or colluvial		Average Forb Cover:	9% (1-17%)
Shallow		Average Total Live Cover:	61.7% (29.6-93.9%)
		Average No. Species:	28 (27-28)

C. Moist Forests (FM)

10. Aspen Ecological Series (POTR5)

Dominance by aspen without any conifers seems to occur in two situations:

1. Unstable slopes where conifers are unable to persist.
2. Sites with adequate moisture at depth, but that are too inhospitable on the surface for conifer trees to get established except rarely. These sites are occupied by aspen by virtue of its extreme persistence due to its clonal nature.

FM1 – *Aspen/serviceberry–Deep Argiborolls–Gentle to moderate slopes and slumps, 8,000-9,700 ft* (POTR5/AMAL2-SYRO).

No. Samples/L&G/S:	16/5/5	Average Elevation:	8,956 ft (8,060-9,700 ft)
Landforms and Geology:		Average Aspect:	5°M (r = 0.25)
Soil creep slopes or slump-earthflows, less often ridges		Average Slope:	19% (7-30%)
Backslopes or summits		Average Coarse in Soil:	36% (9-64%)
Mostly linear		Average Soil Depth:	83 cm (33-170 cm)
Jurassic-Cretaceous shales or sandstones, or Tertiary breccias, granites, or gneisses		Average Mollic Depth:	47 cm (9-170 cm)
		Average Surface Coarse:	3% (0-17%)
Soils:		Average Bare Surface:	2% (0-10%)
Argiborolls, less often Eutroboralfs		Average Tree Cover:	66% (30-93%)
Surface not coarse, less often stony		Average Shrub Cover:	68% (22-120%)
Surface texture variable		Average Graminoid Cover:	78% (6-180%)
Subsurface variable, often loamy		Average Forb Cover:	49% (1-121%)
Parent colluvial, less often residual or old-alluvial		Average Total Live Cover:	262.8% (175.0-403.9%)
Deep, less often very deep or moderately deep		Average No. Species:	26 (11-42)

FM2 – *Aspen/Thurber fescue–Deep Cryoborolls–Gentle to moderate slopes and slumps, 8,100-10,400 ft* (POTR5/FETH)

No. Samples/L&G/S:	32/6/5	Average Elevation:	9,561 ft (8,060-10,380 ft)
Landforms and Geology:		Average Aspect:	224°M (r = 0.17)
Soil creep slopes, less often slump-earthflows		Average Slope:	13% (1-36%)
Backslopes and upper backslopes		Average Coarse in Soil:	35% (4-72%)
Linear to concave		Average Soil Depth:	53 cm (33-97 cm)
Jurassic-Cretaceous sandstones, shales, and siltstones, or granites or gneisses, less often Tertiary basalts		Average Mollic Depth:	39 cm (18-66 cm)
		Average Surface Coarse:	2% (0-17%)
Soils:		Average Bare Surface:	0% (0-10%)
Cryoborolls, often Argic and/or Pachic		Average Tree Cover:	63% (6-96%)
Surface not coarse		Average Shrub Cover:	34% (0-104%)
Surface texture various		Average Graminoid Cover:	112% (44-200%)
Subsurface various, usually clayey		Average Forb Cover:	102% (20-231%)
Parent colluvial		Average Total Live Cover:	311.6% (145.8-545.0%)
Deep, less often very deep or moderately deep		Average No. Species:	21 (12-38)

FM3 – *Aspen/meadow-rue-peavine–Argic **Pachic** Cryoborolls–Gentle to steep slopes, benches, and slumps, 9,100-10,100 ft* (POTR5/THFE-LALE2)

No. Samples/L&G/S:	9/4/4	Average Elevation:	9,714 ft (9,140-10,080 ft)
Landforms and Geology:		Average Aspect:	95°M (r = 0.65)
Soil creep slopes, less often benches, slump-earthflows, or moraines		Average Slope:	25% (7-50%)
From lower backslopes to summits		Average Coarse in Soil:	41% (24-46%)
Linear to concave		Average Soil Depth:	70 cm (26-92 cm)
Tertiary granites or Cretaceous shales		Average Mollic Depth:	48 cm (12-88 cm)
Soils:		Average Surface Coarse:	1% (0-2%)
Cryoborolls, often Argic and/or Pachic		Average Bare Surface:	1% (0-4%)
Surface not coarse		Average Tree Cover:	74% (35-91%)
Surface usually loamy		Average Shrub Cover:	8% (0-31%)
Subsurface usually loamy		Average Graminoid Cover:	107% (41-178%)
Parent colluvial, less often glacial		Average Forb Cover:	144% (75-280%)
Deep		Average Total Live Cover:	333.4% (185.5-491.0%)
		Average No. Species:	24 (13-34)

D. Riparian Forests (FR)

Temperature and drainage are the most important factors in distinguishing among the riparian forested types; geology is not distinctive at all. Three of the riparian forested types – FR1, FR3, FR4 – typically form an elevational sequence in a valley, with FR1 at lower elevations where it is **warmer**, the valley is broader, and the stream deposits are less coarse. FR4 is at the upper end of the sequence, at higher elevations where it's **colder**, narrower, and the stream deposits coarser. FR5 and FR6 are typically associated with steep, rocky, cascading streams (A channels).

11. Narrowleaf Cottonwood Ecological Series (POAN3)

FR1 – *Cottonwood/Pacific willow-swamp bluegrass–Deep to very deep alluvial Fluvaquentic Endoaquolls–U-shaped draw bottoms and floodplains, < 9,400 ft* (POAN3/SALUL-POPA2)

No. Samples/L&G/S:	33/29/21	Average Elevation:	8,369 ft (7,530-9,380 ft)
Landforms and Geology:		Average Aspect:	236°M (r = 0.42)
Draws and floodplains, less often slumps, terraces, benches, or swales, rarely ravines or soil creep slopes		Average Slope:	6% (1-17%)
U-shaped valleys, less often flat or V-shaped		Average Coarse in Soil:	27% (0-81%)
Geology various or mixed, often sedimentary		Average Soil Depth:	100 cm (46-285 cm)
Soils:		Average Mollic Depth:	72 cm (16-160 cm)
Endoaquolls, rarely Argiborolls, Fluvaquents, or Haploborolls		Average Surface Coarse:	9% (0-48%)
Surface not coarse, less often gravelly, stony, or cobbly		Average Bare Surface:	9% (0-38%)
Surface very various		Average Tree Cover:	23% (0-97%)
Subsurface very various		Average Shrub Cover:	53% (0-149%)
Parent alluvial, rarely colluvial		Average Graminoid Cover:	84% (10-291%)
Deep to very deep, rarely moderately deep		Average Forb Cover:	49% (2-177%)
		Average Total Live Cover:	210.6% (45.4-616.5%)
		Average No. Species:	34 (18-55)

FR2 – *Aspen-cottonwood/reedgrass-swamp bluegrass-cow-parsnip–Deep to very deep alluvial Endoaquolls and other Borolls–U-shaped draw bottoms and floodplains, < 9,200 ft* (POTR5-POAN3/CACA4-POPA2-HESP6). These sites may be associated with locally aggrading parts of a stream – such as at the confluence of two streams, or just above a constriction in a valley, or an alluvial flat.

No. Samples/L&G/S:	23/10/6	Average Elevation:	8,466 ft (7,900-9,160 ft)
Landforms and Geology:		Average Aspect:	253°M (r = 0.50)
Draws or floodplains, less often swales or soil creep slopes		Average Slope:	11% (1-30%)
U-shaped valleys, less often flat		Average Coarse in Soil:	35% (7-70%)
Geology various or mixed		Average Soil Depth:	91 cm (43-160 cm)
Soils:		Average Mollic Depth:	83 cm (19-160 cm)
Endoaquolls, less often Pachic Argiborolls or Pachic Haploborolls		Average Surface Coarse:	5% (0-20%)
Surface not coarse, gravelly, or stony		Average Bare Surface:	5% (0-15%)
Surface texture various, often loamy		Average Tree Cover:	61% (10-126%)
Subsurface various, usually clayey		Average Shrub Cover:	64% (7-150%)
Parent alluvial, less often colluvial		Average Graminoid Cover:	107% (16-236%)
Deep to very deep		Average Forb Cover:	67% (2-226%)
		Average Total Live Cover:	300.7% (120.0-557.5%)
		Average No. Species:	28 (14-51)

12. Blue & Engelmann Spruces-Subalpine Fir Riparian Ecological Series (PIPU-PIEN-ABBI2)

FR3 – *Blue spruce-cottonwood/alder-silvertop sedge–Deep alluvial Endoaquolls, sandy subsurface–Flat to U-shaped terraces and floodplains, < 8,900 ft* (PIPU-POAN3/ALINT-CAFO3).

No. Samples/L&G/S:	8/8/4	Average Elevation:	8,212 ft (7,810-8,825 ft)
Landforms and Geology:		Average Aspect:	203°M (r = 0.69)
Terraces and floodplains, less often ravines		Average Slope:	4% (2-6%)
Flat or U-shaped valleys, less often V-shaped valleys		Average Coarse in Soil:	15% (0-30%)
Geology various		Average Soil Depth:	79 cm (74-80 cm)
Soils:		Average Mollic Depth:	36 cm (8-80 cm)
Endoaquolls		Average Surface Coarse:	4% (0-14%)
Surface not coarse, less often cobbly		Average Bare Surface:	2% (0-10%)
Surface loamy		Average Tree Cover:	81% (62-101%)
Subsurface sandy or silty		Average Shrub Cover:	49% (11-139%)
Parent alluvial, less often colluvial		Average Graminoid Cover:	75% (9-182%)
Deep		Average Forb Cover:	41% (10-83%)
		Average Total Live Cover:	250.7% (139.6-332.6%)
		Average No. Species:	31 (23-41)

FR4 – *Spruce/honeysuckle-reedgrass–Deep sandy Cryaquolls and Cryaquents–V- to U-shaped alluvial floodplains and draw bottoms, 2-14% slope, 8,900-10,500 ft* (PIPU-PIEN/DIIN5-CACA4).

No. Samples/L&G/S:	15/5/5	Average Elevation:	9,696 ft (8,960-10,475 ft)
Landforms and Geology:		Average Aspect:	165°M (r = 0.31)
Floodplains or draws		Average Slope:	7% (2-14%)
U-shaped or V-shaped valleys		Average Coarse in Soil:	29% (0-45%)
Geology various		Average Soil Depth:	66 cm (50-82 cm)
Soils:		Average Mollic Depth:	36 cm (0-70 cm)
Cryaquolls or Cryoborolls, less often Cryaquents		Average Surface Coarse:	3% (0-10%)
Surface not coarse, less often stony		Average Bare Surface:	0% (0-0%)
Surface loamy or organic		Average Tree Cover:	81% (10-200%)
Subsurface various		Average Shrub Cover:	66% (1-146%)
Parent alluvial, less often colluvial		Average Graminoid Cover:	105% (5-235%)
Deep, less often moderately deep		Average Forb Cover:	108% (7-265%)
		Average Total Live Cover:	371.8% (197.2-635.5%)
		Average No. Species:	24 (12-48)

FR5 – *Spruce/red-osier–Cryaquolls and Cryaquents–V-shaped, narrow alluvial watercourses, 8,500-9,200 ft* (PIPU-PIEN/SWSE). This ecological type is at **lower elevations**, **warmer**, and has **drier streambanks**, as compared with the next type (FR6).

No. Samples/L&G/S:	6/7/1	Average Elevation:	8,812 ft (8,560-9,180 ft)
Landforms and Geology:		Average Aspect:	194°M (r = 0.73)
Gorges and terraces, less often floodplains, soil creep slopes, or rockslides		Average Slope:	12% (3-36%)
V-shaped valleys		Average Coarse in Soil:	52%
Geology various or mixed		Average Soil Depth:	50 cm
Soils:		Average Mollic Depth:	6 cm
Cryaquolls, less often Cryaquents or Cryoborolls		Average Surface Coarse:	24% (2-95%)
Surface usually with some to much coarse		Average Bare Surface:	9% (0-25%)
Surface texture unknown		Average Tree Cover:	41% (0-109%)
Subsurface texture unknown		Average Shrub Cover:	93% (35-153%)
Parent alluvial or colluvial		Average Graminoid Cover:	21% (3-63%)
Depth unknown		Average Forb Cover:	11% (4-23%)
		Average Total Live Cover:	181.4% (76.4-279.5%)
		Average No. Species:	23 (17-26)

FR6 – *Subalpine fir-Engelmann spruce/Arrowleaf groundsel-bluebells-bittercress–Moderately deep to deep Cryaquolls–V-shaped, narrow ravines and draw bottoms, > 9,500 ft* (ABBI2-PIEN/SETR-MECI3-CACO6). This is the **coldest** of the forested riparian (FR) types, at **higher elevations**, **colder**, and has **moister streambanks**, as compared with the previous type (FR5).

No. Samples/L&G/S:	12/8/3	Average Elevation:	10,254 ft (9,590-11,640 ft)
Landforms and Geology:		Average Aspect:	127°M (r = 0.16)
Ravines and draws, less often erosional terraces, cirque headwalls, or soil creep slopes		Average Slope:	11% (2-27%)
V-shaped valley or concave, less often undulating, U-shaped, or flat		Average Coarse in Soil:	43% (29-59%)
Geology various		Average Soil Depth:	50 cm (20-76 cm)
Soils:		Average Mollic Depth:	26 cm (0-65 cm)
Cryaquolls, less often Cryorthents		Average Surface Coarse:	4% (0-10%)
Surface not coarse, less often gravelly-cobbly-stony		Average Bare Surface:	3% (0-8%)
Surface organic or loamy		Average Tree Cover:	65% (0-142%)
Subsurface sandy and loamy		Average Shrub Cover:	25% (0-92%)
Parent colluvial or alluvial, less often residual		Average Graminoid Cover:	42% (0-130%)
Moderately deep, less often deep or shallow		Average Forb Cover:	93% (23-150%)
		Average Total Live Cover:	231.3% (113.2-415.5%)
		Average No. Species:	23 (7-37)

E. Non-Forested Riparian (RI)

In Non-Forested Riparian (RI) ecological types, soils are too wet or too poorly drained for trees to grow.

13. Yellow Willow Ecological Series (SALU2)

RI1, RI2, and RI3 are in order of decreasing temperature and increasing elevation.

RI1 – *Yellow willow/beaked sedge–Deep to very deep, alluvial to colluvial clayey Endoaquolls–U-shaped or concave draw bottoms, swales, slumps, and earthflows, 7,800-9,700 ft* (SALU2/CAUT). This ecological type occurs at **lower elevations** on **warmer** sites, where the soils are too **poorly drained** for trees, even riparian trees such as narrowleaf cottonwood (POAN3).

No. Samples/L&G/S:	69/52/25	**Average Elevation:**	**8,809 ft (7,800-9,680 ft)**
Landforms and Geology:		Average Aspect:	354°M (r = 0.09)
Draws, less often swales, slump-earthflows, or soil creep slopes, rarely ravines, benches, or terraces		Average Slope:	6% (0-20%)
U-shaped narrow valleys, less often linear slopes or concave slopes		Average Coarse in Soil:	24% (0-76%)
Geology various or mixed		Average Soil Depth:	111 cm (33-203 cm)
Soils:		Average Mollic Depth:	89 cm (11-203 cm)
Endoaquolls, less often Argiborolls, rarely Endoaquents or Haploborolls		Average Surface Coarse:	3% (0-31%)
Surface not coarse		Average Bare Surface:	11% (0-40%)
Surface texture various		Average Tree Cover:	0% (0-2%)
Subsurface various, often clayey		Average Shrub Cover:	40% (0-161%)
Parent alluvial, less often colluvial		Average Graminoid Cover:	140% (7-295%)
Deep, less often very deep or moderately deep		Average Forb Cover:	84% (9-319%)
		Average Total Live Cover:	266.2% (99.0-595.5%)
		Average No. Species:	29 (9-56)

14. Blue Willow-Serviceberry Willow-Booth Willow Ecological Series (SADR-SAMO2-SABO2)

RI2 – *Blue willow/reedgrass-beaked sedge–Deep to moderately deep alluvial Cryaquolls–U-shaped or flat floodplains, terraces, and draw bottoms, 8,500-10,200 ft* (SADR/CACA4-CAUT).

No. Samples/L&G/S:	17/17/6	Average Elevation:	9,291 ft (8,560-10,160 ft)
Landforms and Geology:		Average Aspect:	204°M (r = 0.36)
Floodplains, terraces, or draws, less often canyons		Average Slope:	3% (0-12%)
U-shaped valleys, less often flat valley bottoms		Average Coarse in Soil:	35% (8-60%)
Geology various		Average Soil Depth:	70 cm (50-92 cm)
Soils:		Average Mollic Depth:	48 cm (16-71 cm)
Cryaquolls, less often Cryaquents		Average Surface Coarse:	4% (0-15%)
Surface not coarse, less often gravelly		Average Bare Surface:	9% (0-40%)
Surface texture various		Average Tree Cover:	6% (0-57%)
Subsurface various, often silty or sandy		Average Shrub Cover:	83% (14-155%)
Parent alluvial, rarely colluvial		Average Graminoid Cover:	85% (6-185%)
Deep, less often very deep		Average Forb Cover:	57% (8-193%)
		Average Total Live Cover:	238.9% (127.8-422.9%)
		Average No. Species:	27 (11-41)

RI3 – *Serviceberry willow/beaked sedge–Deep to very deep alluvial to colluvial silty to clayey Cryaquolls, sometimes Histic–U-shaped or flat draws, slopes, floodplains, swales, benches, ravines, and slumps, 8,100-11,000 ft* (SAMO2/CAUT).

No. Samples/L&G/S:	34/24/11	Average Elevation:	9,468 ft (8,160-10,970 ft)
Landforms and Geology:		Average Aspect:	188°M (r = 0.41)
Draws, soil creep slopes, floodplains, and swales, less often many others		Average Slope:	6% (0-25%)
U-shaped valleys, less often flat valleys or toeslopes		Average Coarse in Soil:	19% (0-47%)
Geology various or mixed		Average Soil Depth:	102 cm (71-168 cm)
Soils:		Average Mollic Depth:	75 cm (41-168 cm)
Cryaquolls, less often Borohemists, rarely Endoaquolls		Average Surface Coarse:	2% (0-10%)
Surface not coarse		Average Bare Surface:	18% (0-75%)
Surface texture various		Average Tree Cover:	1% (0-15%)
Subsurface various, often silty or sandy		Average Shrub Cover:	55% (0-147%)
Parent alluvial or colluvial, rarely glacial		Average Graminoid Cover:	127% (50-226%)
Deep, less often very deep		Average Forb Cover:	84% (13-191%)
		Average Total Live Cover:	268.5% (125.6-425.0%)
		Average No. Species:	29 (10-59)

15. Planeleaf Willow-Wolf Willow-Bog Birch Ecological Series (SAPL2-SAWO-BEGL)

At lower elevations, ecological types in this Series are often associated with a stream, but at higher elevations they become less and less stream dependent.

RI4 – *Planeleaf willow/water sedge–Deep to very deep alluvial Cryaquolls and Borohemists–U-shaped or flat floodplains, draw bottoms, benches, slumps, and swales, > 9,500 ft* (SAPL2/CAAQ)

No. Samples/L&G/S:	19/17/8	Average Elevation:	10,353 ft (9,540-12,040 ft)
Landforms and Geology:		Average Aspect:	57°M (r = 0.45)
Floodplains, less often draws or benches, rarely slump-earthflows, swales, moraines, seeps, soil creep slopes, or cirques		Average Slope:	2% (0-7%)
U-shaped or flat-bottomed valleys, rarely linear slopes		Average Coarse in Soil:	31% (11-46%)
Geology various		Average Soil Depth:	58 cm (31-70 cm)
Soils:		Average Mollic Depth:	28 cm (0-70 cm)
Cryaquolls, less often Borohemists, rarely Cryaquents		Average Surface Coarse:	1% (0-2%)
Surface not coarse		Average Bare Surface:	3% (0-25%)
Surface often silty		Average Tree Cover:	0% (0-1%)
Subsurface various		Average Shrub Cover:	66% (4-186%)
Parent alluvial, less often colluvial, rarely glacial or residual		Average Graminoid Cover:	93% (23-147%)
		Average Forb Cover:	49% (8-113%)
		Average Total Live Cover:	208.5% (121.5-328.8%)
		Average No. Species:	27 (12-49)

RI5 – *Wolf's-planeleaf willows/water sedge–Deep alluvial Cryaquolls and Cryohemists–Flat to U-shaped floodplains and terraces, > 9,500 ft* (SAWO-SAPL2/CAAQ)

No. Samples/L&G/S:	14/13/10	Average Elevation:	9,895 ft (9,510-10,650 ft)
Landforms and Geology:		Average Aspect:	161°M (r = 0.28)
Floodplains and terraces		Average Slope:	2% (1-4%)
Flat-bottomed valleys, less often U-shaped valleys		Average Coarse in Soil:	14% (0-27%)
Geology various or mixed		Average Soil Depth:	78 cm (60-100 cm)
Soils:		Average Mollic Depth:	53 cm (22-90 cm)
Cryaquolls, less often Cryohemists		Average Surface Coarse:	0% (0-6%)
Surface not coarse		Average Bare Surface:	9% (0-100%)
Surface texture various		Average Tree Cover:	0% (0-1%)
Subsurface various		Average Shrub Cover:	101% (40-167%)
Parent alluvial		Average Graminoid Cover:	99% (25-158%)
Deep		Average Forb Cover:	58% (7-105%)
		Average Total Live Cover:	259.8% (176.5-332.5%)
		Average No. Species:	24 (13-35)

RI6 – *Shrubby cinquefoil/Idaho fescue–Moderately deep colluvial to alluvial clayey Cryoborolls–Linear to concave to U-shaped footslopes and draw bottoms, 9,000-10,800 ft* (PEFL15/FEID). The sites in this ecological type are too wet for sagebrush early in the summer, but later they become too dry to support willows. In other words, they have a seasonally fluctuating water table, often related to historical removal of vegetation by grazing.

No. Samples/L&G/S:	10/10/2	Average Elevation:	9,768 ft (9,080-10,760 ft)
Landforms and Geology:		Average Aspect:	207°M (r = 0.20)
Soil creep slopes, less often draws		Average Slope:	12% (3-47%)
Footslopes, less often toeslopes, rarely U-shaped valleys		Average Coarse in Soil:	42% (32-53%)
Concave to linear		Average Soil Depth:	54 cm (52-56 cm)
Geology various		Average Mollic Depth:	25 cm (22-28 cm)
Soils:		Average Surface Coarse:	5% (0-18%)
Cryoborolls		Average Bare Surface:	19% (0-100%)
Surface not coarse, less often gravelly or gravelly-cobbly-stony		Average Tree Cover:	1% (0-6%)
Surface loamy		Average Shrub Cover:	36% (2-75%)
Subsurface clayey		Average Graminoid Cover:	88% (37-170%)
Parent alluvial, less often colluvial		Average Forb Cover:	59% (17-110%)
Moderately deep		Average Total Live Cover:	184.3% (110.8-311.0%)
		Average No. Species:	26 (12-41)

RI7 – *Planeleaf willow/marsh-marigold–Cryaquepts–Concave footslopes and lower backslopes, > 11,500 ft* (SAPL2/PSLE). This ecological type occurs in very cold, high elevations sites with water-saturated soil, but often it is not associated with a stream.

No. Samples/L&G/S:	2/3/0	Average Elevation:	11,963 ft (11,640-12,285 ft)
Landforms and Geology:		Average Aspect:	207°M (r = 0.20)
Soil creep slopes or swales		Average Slope:	4% (3-4%)
Footslopes, less often lower backslopes		Average Coarse in Soil:	
Usually concave		Average Soil Depth:	33 cm (20-46 cm)
Granites or Tertiary granites or breccias		Average Mollic Depth:	
Soils:		Average Surface Coarse:	1% (1-1%)
Cryaquepts		Average Bare Surface:	3% (0-5%)
Surface not coarse		Average Tree Cover:	0% (0-0%)
Surface texture unknown		Average Shrub Cover:	100% (100-100%)
Subsurface texture unknown		Average Graminoid Cover:	8% (1-16%)
Parent colluvial		Average Forb Cover:	47% (39-54%)
Depth unknown		Average Total Live Cover:	154.8% (139.8-169.8%)
		Average No. Species:	28 (26-29)

16. Grayleaf Willow-Barrenground Willow Ecological Series (SAGL-SABR)

RI8 – *Grayleaf-barrenground willows/water sedge–Deep to very deep Cryaquolls and Borohemists–U-shaped or flat-linear floodplains and benches, 9,500-12,100 ft* (SAGL-SABR/CAAQ). This ecological type is often not associated with a stream course, but forms low wetlands on U-shaped landforms.

No. Samples/L&G/S:	7/8/5	Average Elevation:	10,774 ft (9,640-12,080 ft)
Landforms and Geology:		Average Aspect:	289°M (r = 0.26)
Floodplains, less often benches, soil creep slopes, frost creep slopes, or draws		Average Slope:	7% (0-22%)
		Average Coarse in Soil:	37% (5-63%)
U-shaped or flat valleys, or linear-convex backslopes		Average Soil Depth:	87 cm (33-136 cm)
Geology various		Average Mollic Depth:	52 cm (0-136 cm)
Soils:		Average Surface Coarse:	1% (0-4%)
Cryaquolls or Borohemists, less often Cryumbrepts		Average Bare Surface:	1% (0-4%)
Surface not coarse		Average Tree Cover:	0% (0-0%)
Surface organic or loams		Average Shrub Cover:	103% (69-146%)
Subsurface clays, sandy loams, clay loams, or sandy clay loams		Average Graminoid Cover:	66% (2-101%)
		Average Forb Cover:	65% (38-127%)
Parent alluvial, less often colluvial		Average Total Live Cover:	234.1% (141.8-295.8%)
Deep to very deep		Average No. Species:	28 (17-34)

17. Water Sedge Ecological Series (CAAQ)

RI9 – *Water sedge-beaked sedge/tufted hairgrass–Very deep to deep Borohemists, Cryaquolls, and Cryaquepts–Flat to U-shaped floodplains, draw bottoms, and toeslopes, > 9,500 ft* (CAAQ-CAUT/DECE). This ecological type is too **wet** and **poorly drained** even for willows. Often it occurs in closed **depressions** on floodplains or moraines.

No. Samples/L&G/S:	18/18/4	Average Elevation:	10,382 ft (9,530-12,040 ft)
Landforms and Geology:		Average Aspect:	139°M (r = 0.23)
Floodplains, less often draws, soil creep slopes, swales, moraines, benches, or cirques		Average Slope:	1% (0-5%)
Flat valleys bottoms, less often footslopes		Average Coarse in Soil:	13% (0-39%)
Geology various		Average Soil Depth:	95 cm (15-155 cm)
Soils:		Average Mollic Depth:	59 cm (0-125 cm)
Borohemists, Cryaquolls, or Cryaquepts, less often Cryoborolls		Average Surface Coarse:	2% (0-25%)
Surface not coarse, rarely gravelly		Average Bare Surface:	13% (0-45%)
Surface usually organic		Average Tree Cover:	0% (0-0%)
Subsurface usually organic		Average Shrub Cover:	1% (0-8%)
Parent alluvial, less often colluvial, glacial, or residual		Average Graminoid Cover:	93% (7-196%)
Very deep to deep		Average Forb Cover:	32% (0-161%)
		Average Total Live Cover:	128.8% (45.2-278.8%)
		Average No. Species:	13 (5-21)

F. Non-Riparian Grasslands (GA)

Aspect appears to be significant for all Non-Riparian Grasslands (GA) ecological types. All of them are **not northerly** except GA06, which has low slope angle. Four of the ecological types (GA01, GA02, GA03, GA10) tend to be on **convex** sites (drier), while all the other ecological types tend to be on **concave** sites (moister). The first three ecological types (GA01, GA02, GA03) are characteristic of the **Foothills** to **Montane** belts, the next five ecological types (GA04, GA05, GA06, GA07, GA08) **Subalpine**, and the last two (GA09, GA10) are both **Subalpine** and **Alpine**.

18. Indian Ricegrass-Needle-and-thread Ecological Series (ACHY-HECO26)

GA01 – *Indian ricegrass/needle-and-thread-blue grama–Moderately deep to shallow **Aridic** Mesic soils, gravelly surface–**Convex windward** summits and shoulders, 7,500-9,400 ft* (ACHY/HECO26-CHGR15). This is a **very dry** ecological type. It is also relatively **warm** for the climates of the UGB. It is distributed **outside rainshadow climates** in the UGB. Characteristic of the **Foothills** to **Montane** belts.

No. Samples/L&G/S:	18/16/15	Average Elevation:	8,511 ft (7,680-9,370 ft)
Landforms and Geology:		**Average Aspect:**	**240°M (r = 0.47)**
Soil creep slopes, mesas, and ridges, less often slump-earthflows or pediments		Average Slope:	18% (1-44%)
Summits, shoulders, and backslopes, less often footslopes or toeslopes		Average Coarse in Soil:	59% (27-93%)
Usually convex horizontally and linear vertically		Average Soil Depth:	54 cm (26-100 cm)
Tertiary tuffs (most welded), granites, and breccias, less often Cretaceous sandstones and mudstones, rarely gneisses		Average Mollic Depth:	16 cm (0-37 cm)
Exposed to wind		Average Surface Coarse:	48% (0-74%)
Soils:		Average Bare Surface:	11% (0-41%)
Argiborolls (mostly **Aridic**) and Lithic Haploborolls, rarely Camborthids or Ustochrepts		Average Tree Cover:	0% (0-0%)
Surface usually gravelly, most often very or extremely so, often cobbly as well, rarely not coarse		Average Shrub Cover:	8% (0-24%)
Surface texture various, usually loamy		Average Graminoid Cover:	67% (24-119%)
Subsurface various		Average Forb Cover:	15% (1-47%)
Parent residual, colluvial, or colluvial over residual		Average Total Live Cover:	89.3% (44.9-167.2%)
Moderately deep, less often shallow or deep, rarely very deep		Average No. Species:	27 (19-37)

19. Arizona Fescue Ecological Series (FEAR2)

GA02 – *Arizona fescue/pingue–Moderately deep to shallow residual Argiborolls, gravelly surface–Linear to* ***convex exposed*** *shoulders and summits, 8,400-9,600 ft* (FEAR2/PIRI6). This ecological type is distributed in **partial to deep rainshadows** in the UGB. This ecological type is **exposed**, which may correlate with the deeply-rooted pingue (PIRI6), as contrasted with mountain muhly (MUMO) in the somewhat protected GA03, the next ecological type. Characteristic of the **Montane** belt.

No. Samples/L&G/S:	19/17/14	Average Elevation:	9,041 ft (8,420-9,520 ft)
Landforms and Geology:		**Average Aspect:**	**268°M (r = 0.86)**
Mesas, ridges, and soil creep slopes, less often benches		Average Slope:	20% (6-34%)
Usually shoulders, less often summits or backslopes		Average Coarse in Soil:	69% (36-87%)
Linear to convex horizontally, convex to linear vertically		Average Soil Depth:	64 cm (26-162 cm)
Tertiary tuffs (some welded) and breccias, less often granites, lavas, or basalts		Average Mollic Depth:	20 cm (7-40 cm)
		Average Surface Coarse:	58% (24-77%)
Soils:		Average Bare Surface:	7% (1-19%)
Argiborolls of various subgroups, less often Lithic Haploborolls		Average Tree Cover:	0% (0-0%)
Surface usually gravelly, often very or extremely so, less often cobbly or stony		Average Shrub Cover:	9% (0-21%)
Surface texture various, often loamy		Average Graminoid Cover:	42% (18-73%)
Subsurface various, usually clayey and loamy		Average Forb Cover:	20% (5-67%)
Parent mostly residual, less often colluvial or colluvial over residual		Average Total Live Cover:	71.4% (43.7-140.9%)
Moderately deep to shallow, less often deep, rarely very deep		Average No. Species:	30 (22-39)

GA03 – *Arizona fescue/muhly–Shallow to deep colluvial Argiborolls, sometimes Lithic, gravelly surface–Linear to* ***convex somewhat protected*** *slopes, 8,700-10,500 ft* (FEAR2/MUMO-MUFI). This ecological type is **somewhat protected**, which may correlate with the shallow-rooted mountain muhly (MUMO), as contrasted with the deeper-rooted pingue (PIRI6) in the previous ecological type. Characteristic of the **Montane** belt.

No. Samples/L&G/S:	20/18/11	Average Elevation:	9,669 ft (8,760-10,480 ft)
Landforms and Geology:		**Average Aspect:**	**166°M (r = 0.54)**
Soil creep slopes, less often benches, ridges, or slump-earthflows		Average Slope:	25% (6-111%)
Backslopes, less often footslopes or toeslopes, rarely summits or shoulders		Average Coarse in Soil:	54% (14-79%)
Usually linear		Average Soil Depth:	54 cm (20-95 cm)
Tertiary tuffs (some welded), breccias, basalts, and rhyolites, rarely gneisses or schists		Average Mollic Depth:	22 cm (0-52 cm)
		Average Surface Coarse:	30% (5-71%)
Soils:		Average Bare Surface:	31% (1-90%)
Argiborolls and Cryoborolls (often Lithic), rarely Lithic Haploborolls		Average Tree Cover:	0% (0-0%)
Surface gravelly, less often stony or gravelly-cobbly-stony, rarely cobbly or not coarse		Average Shrub Cover:	7% (0-41%)
Surface usually clay loams (silty, sandy, or loamy), less often loams, rarely silt loams, silty clays, or sandy loams		Average Graminoid Cover:	59% (15-117%)
Subsurface various, clayier than surface		Average Forb Cover:	22% (3-54%)
Parent **colluvial**, less often residual or colluvial over residual		Average Total Live Cover:	88.1% (29.4-167.0%)
Shallow, less often deep or moderately deep		Average No. Species:	27 (17-38)

20. Thurber Fescue Ecological Series (FETH)

All of the ecological types in this ecological series have a **thick Mollic epipedon**, apparently a rooting requirement for Thurber fescue. Usually the Mollic epipedon is not very fine-textured, a light clay loam at the most.

GA04 – *Thurber fescue/Arizona fescue–Deep Argic Cryoborolls, not coarse on surface–Linear protected footslopes and toeslopes, 9,200-10,800 ft* (FETH/FEAR2). Characteristic of the **Subalpine** belt, which seems to correspond here with the **Cryic** soil temperature regime. Since this ecological type is in the lower Subalpine belt, it borders on the Montane, so the temperature regime often appears to be close to the Frigid soil temperature regime. The temperature of this ecological type seems to be a bit warmer than the next ecological type (GA05).

No. Samples/L&G/S:	12/12/8	Average Elevation:	10,072 ft (9,210-10,800 ft)
Landforms and Geology:		**Average Aspect:**	**133°M (r = 0.83)**
Soil creep slopes, rarely lateral moraines or ridges		Average Slope:	17% (4-49%)
Footslopes, lower backslopes, and toeslopes, rarely shoulders		Average Coarse in Soil:	50% (19-85%)
Linear horizontally, concave to linear vertically		Average Soil Depth:	69 cm (46-87 cm)
Tertiary tuffs, less often shales, sandstones, or conglomerates		Average Mollic Depth:	37 cm (13-65 cm)
Soils:		Average Surface Coarse:	4% (1-19%)
Cryoborolls, often Argic and/or Pachic		Average Bare Surface:	9% (0-30%)
Surface not coarse, rarely gravelly		Average Tree Cover:	0% (0-0%)
Surface texture various, usually loamy		Average Shrub Cover:	3% (0-11%)
Subsurface various, usually clayier than surface		Average Graminoid Cover:	121% (80-153%)
Parent colluvial, rarely glacial		Average Forb Cover:	35% (8-83%)
Deep		Average Total Live Cover:	158.7% (105.8-201.5%)
		Average No. Species:	25 (20-36)

GA05 – *Thurber fescue/Idaho fescue–Deep Argic Cryoborolls, not coarse on surface–Linear to concave toeslopes and footslopes, 9,500-11,200 ft* (FETH/FEID). Characteristic of the **Subalpine** belt, which seems to correspond here with the **Cryic** soil temperature regime. The temperature of this ecological type seems to be a bit colder than the previous ecological type (GA04).

No. Samples/L&G/S:	12/11/5	Average Elevation:	10,212 ft (9,500-11,120 ft)
Landforms and Geology:		Average Aspect:	141°M (r = 0.59)
Soil creep slopes, less often slump-earthflows, rarely moraines, mesas, or stream terraces		Average Slope:	9% (2-31%)
Toeslopes and footslopes, rarely backslopes or summits		Average Coarse in Soil:	45% (30-55%)
Usually linear horizontally and concave vertically		Average Soil Depth:	68 cm (41-116 cm)
Tertiary tuffs and basalts, less often shales or sandstones, rarely granites		Average Mollic Depth:	45 cm (18-116 cm)
Soils:		Average Surface Coarse:	3% (0-9%)
Cryoborolls, often Argic, rarely Pachic		Average Bare Surface:	25% (8-60%)
Surface not coarse		Average Tree Cover:	0% (0-2%)
Surface loams or silt loams, rarely clay loams		Average Shrub Cover:	8% (0-72%)
Subsurface various, usually clayey		Average Graminoid Cover:	83% (14-147%)
Parent colluvial, less often alluvial, residual, glacial, or colluvial over residual		Average Forb Cover:	53% (10-112%)
Deep, rarely very deep		Average Total Live Cover:	144.8% (89.5-217.6%)
		Average No. Species:	27 (18-34)

GA06 – *Thurber fescue/meadow-rue-vetch-elk sedge–Deep to very deep Argic Cryoborolls, sometimes Pachic, not coarse on surface–Linear to concave backslopes and footslopes, 8,700-11,300 ft* (FETH/THFE-VIAM-CAGE2). Characteristic of the **Subalpine** belt, which seems to correspond here with the **Cryic** soil temperature regime. This ecological type is **moister** than the other two Thurber fescue types (GA04, GA05), but is **less clayey** (especially in the surface horizons) and **more stable** than the next type (GA07).

No. Samples/L&G/S:	12/11/9	Average Elevation:	10,024 ft (8,700-11,240 ft)
Landforms and Geology:		Average Aspect:	140°M (r = 0.25)
Soil creep slopes, less often slump-earthflows, rarely moraines or benches		Average Slope:	16% (4-30%)
Usually lower backslopes, less often footslopes, rarely upper backslopes, toeslopes, shoulders, or summits		Average Coarse in Soil:	24% (1-53%)
Usually linear horizontally and concave vertically		Average Soil Depth:	101 cm (52-190 cm)
Cretaceous sandstones, shales, mudstones, and limestones, less often Tertiary granites, gneisses, and schists, rarely a wide variety of others		Average Mollic Depth:	48 cm (18-94 cm)
		Average Surface Coarse:	2% (0-8%)
		Average Bare Surface:	6% (0-25%)
		Average Tree Cover:	0% (0-2%)
		Average Shrub Cover:	3% (0-16%)
		Average Graminoid Cover:	130% (103-154%)
		Average Forb Cover:	88% (18-181%)
		Average Total Live Cover:	221.5% (129.0-334.3%)
		Average No. Species:	31 (20-39)
Soils:			
Argic Cryoborolls, **often Pachic** as well			
Surface not coarse			
Surface usually **loams**			
Subsurface **various**, usually clayey			
Parent colluvial, rarely old-alluvial, colluvial over residual, or glacial			
Deep to very deep			

21. Osha Ecological Series (LIPO)

GA07 – *Osha/meadow-rue–Very deep Argic Cryoborolls, not coarse on surface–Linear to concave slumps and earthflows, > 9,000 ft* (LIPO/THFE). Characteristic of the **Subalpine** belt, which seems to correspond here with the **Cryic** soil temperature regime. This ecological type is **more clayey** (especially in the surface horizons) and **less stable** than the preceding type (GA06).

No. Samples/L&G/S:	6/4/3	Average Elevation:	9,752 ft (9,100-10,100 ft)
Landforms and Geology:		Average Aspect:	89°M (r = 0.70)
Slump-earthflows, less often soil creep slopes or scarps		Average Slope:	24% (5-40%)
Backslopes		Average Coarse in Soil:	16% (4-25%)
Usually linear horizontally and concave vertically		Average Soil Depth:	89 cm (65-111 cm)
Cretaceous shales and claystones, less often Tertiary granites		Average Mollic Depth:	49 cm (3-78 cm)
		Average Surface Coarse:	4% (0-10%)
		Average Bare Surface:	17% (2-27%)
		Average Tree Cover:	0% (0-0%)
		Average Shrub Cover:	3% (0-16%)
		Average Graminoid Cover:	56% (3-114%)
		Average Forb Cover:	145% (69-203%)
		Average Total Live Cover:	203.5% (124.5-282.5%)
		Average No. Species:	24 (20-32)
Soils:			
Cryoborolls, sometimes Argic			
Surface not coarse, less often gravelly			
Surface **silty clay loam or silty clay**			
Subsurface **clay or silty clay**			
Parent colluvial, less often residual			
Very deep to deep			

22. Idaho Fescue Ecological Series (FEID)

GA08 – *Idaho fescue/slender wheatgrass–Very deep Argic Cryoborolls, shallow to Argillic, not coarse on surface–Concave backslopes and footslopes, > 9,700 ft* (FEID/ELTR7). Characteristic of the **Subalpine** belt, which seems to correspond here with the **Cryic** soil temperature regime. This ecological type has a **shallower Mollic** epipedon than any of the Thurber fescue types, especially the type (GA05) codominated by Idaho fescue (FEID), apparently corresponding to the shallower roots of Idaho fescue as contrasted with the deep roots of Thurber fescue. The one soil sample in fact is not "technically" Mollic. This ecological type also appears to be **drier** and **better drained** than GA05, due to slope position and sandier texture.

No. Samples/L&G/S:	4/4/1	Average Elevation:	10,285 ft (9,720-10,810 ft)
Landforms and Geology:		Average Aspect:	180°M (r = 0.80)
Soil creep slopes, less often floodplains		Average Slope:	2% (0-5%)
Backslopes, less often footslopes		Average Coarse in Soil:	30%
Concave to linear horizontally, usually concave vertically		Average Soil Depth:	94 cm
Tertiary tuffs, basalts, and breccias		**Average Mollic Depth:**	**12 cm**
Soils:		Average Surface Coarse:	5% (1-14%)
Argic Cryoborolls		Average Bare Surface:	22% (4-50%)
Surface not coarse, less often gravelly		Average Tree Cover:	0% (0-0%)
Surface **sandy loams**		Average Shrub Cover:	1% (0-2%)
Subsurface **silt loams or sandy clay loams**		Average Graminoid Cover:	78% (7-119%)
Parent colluvial, less often alluvial		Average Forb Cover:	59% (20-94%)
Very deep		Average Total Live Cover:	137.8% (85.8-174.1%)
		Average No. Species:	24 (20-32)

23. Timber Oatgrass Ecological Series (DAIN)

GA09 – *Timber oatgrass/tufted hairgrass–Shallow Cryumbrepts and Cryoborolls–Windward, **somewhat protected** footslopes and toeslopes, > 10,500 ft* (DAIN/DECE). This ecological type occurs in the **upper Subalpine** and **lower Alpine** belts. It is **somewhat protected** and at **lower elevations** as compared with the next type (GA10). This type sometimes forms a mosaic with RI7 or RI8, where those types are not stream dependent.

No. Samples/L&G/S:	4/3/0	Average Elevation:	11,108 ft (**10,580-11,960 ft**)
Landforms and Geology:		Average Aspect:	297°M (r = 0.79)
Soil creep slopes, less often moraines		Average Slope:	4% (2-7%)
Footslopes, less often toeslopes or lower backslopes		Average Coarse in Soil:	30%
Usually linear horizontally and **concave vertically**		Average Soil Depth:	20 cm
Geology various		Average Mollic Depth:	(no data)
Soils:		Average Surface Coarse:	2% (2-3%)
Cryumbrepts, less often Cryoborolls		Average Bare Surface:	13% (5-30%)
Surface not coarse		Average Tree Cover:	0% (0-0%)
Surface texture unknown		Average Shrub Cover:	2% (0-4%)
Subsurface texture unknown		Average Graminoid Cover:	72% (51-95%)
Parent colluvial or glacial		Average Forb Cover:	37% (20-65%)
Depth unknown		Average Total Live Cover:	111.0% (93.0-125.6%)
		Average No. Species:	29 (22-38)

24. Purple Pinegrass Ecological Series (CAPU)

GA10 – *Purple pinegrass/Scribner wheatgrass–Moderately deep, gravelly and rocky residual Cryoborolls–Windward, exposed shoulders and summits of ridges, > 11,200 ft* (CAPU/ELSC4). This ecological type is essentially a **lower Alpine** type that sometimes occurs within the **Subalpine** belt. It is **exposed** to wind and at higher elevations as compared with the previous type (GA09).

No. Samples/L&G/S:	3/3/1	Average Elevation:	11,813 ft (**11,200-12,380 ft**)
Landforms and Geology:		Average Aspect:	214°M (r = 0.51)
Ridges		Average Slope:	22% (11-41%)
Shoulders and summits		Average Coarse in Soil:	79%
Usually convex		Average Soil Depth:	57 cm
Tertiary breccias and granites		Average Mollic Depth:	38 cm
Soils:		Average Surface Coarse:	42% (18-63%)
Cryoborolls		Average Bare Surface:	5% (4-5%)
Surface gravelly or cobbly		Average Tree Cover:	0% (0-0%)
Surface sandy loams or sandy clay loams		Average Shrub Cover:	0% (0-0%)
Subsurface loamy sands		Average Graminoid Cover:	65% (43-90%)
Parent residual		Average Forb Cover:	29% (24-34%)
Moderately deep		Average Total Live Cover:	94.1% (71.0-124.6%)
		Average No. Species:	28 (25-30)

G. Tall Non-Riparian Shrublands (SA)

25. Utah Serviceberry-Saskatoon Serviceberry Ecological Series (AMUT-AMAL2)

Serviceberry types usually are adjacent to sites dominated by big sagebrush, but where there is greater moisture in the deeper parts of the soil. The greater subsoil moisture often occurs because the sites are snow accumulation areas, especially on the lee side of ridges. But these sites of greater subsoil moisture may also occur where rock strata duct groundwater laterally to the surface, and may sometimes also occur along ephemeral streams too dry for riparian vegetation. Within this Series, the Utah serviceberry (AMUT) types are **warmer** and **drier**, and average at lower elevations, than the Saskatoon serviceberry types (AMAL2), with the combined types (SA3 and SA4) in between.

SA1 – *Utah serviceberry/dryland sedge-sun sedge–Deep Argiborolls–**Leeward** upper backslopes and shoulders, < 9,100 ft* (AMUT/CAGE-CAPEH). This type is always on upper, strictly **leeward** slopes, always to the east of protective ridges; the next type (SA2) can also occur in other protected sites, such as lower west-facing slopes.

No. Samples/L&G/S:	37/34/30	Average Elevation:	8,525 ft (8,000-9,036 ft)
Landforms and Geology:		Average Aspect:	54°M (r = 0.35)
Soil creep slopes and ridges, less often mesas, slump-earthflows, or benches		Average Slope:	22% (1-64%)
Upper backslopes, shoulders, and backslopes, less often lower backslopes, toeslopes or summits, rarely footslopes		Average Coarse in Soil:	53% (14-76%)
Linear horizontally, **concave** to linear vertically		Average Soil Depth:	48 cm (20-74 cm)
Tertiary tuffs and Cretaceous shales, sandstones, and mudstones, less often basalts or breccias		Average Mollic Depth:	32 cm (0-66 cm)
Soils:		Average Surface Coarse:	21% (0-50%)
Argiborolls (**often Pachic**), less often Haploborolls (**often Pachic**) or Eutroboralfs		Average Bare Surface:	13% (1-55%)
Surface gravelly, less often not coarse or cobbly, rarely stony		Average Tree Cover:	0% (0-5%)
Surface texture various, usually clay loams or loams		Average Shrub Cover:	58% (22-124%)
Subsurface various, usually clays or clay loams		Average Graminoid Cover:	44% (1-148%)
Parent colluvial and colluvial over residual, less often residual or old-alluvial		Average Forb Cover:	18% (1-87%)
Moderately deep to deep, rarely shallow or very deep		Average Total Live Cover:	119.1% (43.4-317.3%)
		Average No. Species:	36 (16-53)

SA2 – *Utah serviceberry-mountain-mahogany/dryland sedge-sun sedge–Argiborolls–**Protected** colluvial backslopes and shoulders, < 8,700 ft* (AMUT-CEMO2/CAGE-CAPEH). This type can occur in the lee of protective ridges, but may sometimes occur in other **protected** sites, such as lower- west-facing slopes. This ecological type is **better drained** than the preceding type (SA1).

No. Samples/L&G/S:	16/16/14	Average Elevation:	8,303 ft (7,600-8,640 ft)
Landforms and Geology:		Average Aspect:	348°M (r = 0.61)
Soil creep slopes, less often mesas or ridges, rarely slump-earthflows		Average Slope:	35% (12-53%)
Backslopes, upper backslopes, and shoulders, rarely lower backslopes, footslopes, toeslopes, or summits		Average Coarse in Soil:	53% (20-79%)
Usually linear both directions, less often convex		Average Soil Depth:	49 cm (13-85 cm)
Tertiary tuffs, breccias, and basalts, less often Jurassic-Cretaceous sandstones, mudstones, or shales		Average Mollic Depth:	27 cm (0-85 cm)
Leeward or not		Average Surface Coarse:	25% (5-66%)
Soils:		Average Bare Surface:	6% (0-24%)
Argiborolls (**sometimes Pachic**), less often Lithic Haploborolls, rarely Ustochrepts		Average Tree Cover:	0% (0-2%)
Surface very cobbly, very gravelly, or stony, rarely not coarse		Average Shrub Cover:	91% (57-147%)
Surface loams, sandy loams, or sandy clay loams, rarely other		Average Graminoid Cover:	51% (11-96%)
Subsurface clays, clay loams, or sandy clays, less often sandy loams or sandy clay loams		Average Forb Cover:	13% (0-27%)
Parent colluvial or colluvial or residual, rarely residual		Average Total Live Cover:	155.1% (88.7-218.6%)
Deep to moderately deep to shallow		Average No. Species:	32 (23-46)

SA3 – *Serviceberry-Gambel oak/sedge–Deep Argiborolls, little coarse on surface–**Lees or other protected** slopes, 7,600 - 8,600 ft* (AMUT-AMAL2-QUGA/CAGE-CAGE2).

No. Samples/L&G/S:	16/17/4	Average Elevation:	8,176 ft (7,600-8,600 ft)
Landforms and Geology:		Average Aspect:	304°M (r = 0.10)
Soil creep slopes, less often mesas or ridges		Average Slope:	26% (10-40%)
Backslopes, upper backslopes, and shoulders, less often summits, rarely lower backslopes		Average Coarse in Soil:	48% (16-84%)
Usually linear both directions, less often convex or concave		Average Soil Depth:	50 cm (35-69 cm)
Tertiary tuffs and breccias, less often Jurassic sandstones or mudstones		Average Mollic Depth:	31 cm (20-37 cm)
Leeward or not		Average Surface Coarse:	4% (2-7%)
Soils:		Average Bare Surface:	0% (0-0%)
Argiborolls, less often Haploborolls		Average Tree Cover:	2% (0-12%)
Surface not coarse		Average Shrub Cover:	86% (38-203%)
Surface loamy, often silty to sandy		Average Graminoid Cover:	38% (4-95%)
Subsurface clayier than surface		Average Forb Cover:	13% (0-81%)
Parent Colluvial, less often residual		Average Total Live Cover:	139.6% (70.0-369.6%)
Deep to moderately deep		Average No. Species:	23 (13-41)

SA4 – *Serviceberry/green needlegrass-spike-fescue-littleseed ricegrass–Deep Argiborolls, sometimes Pachic–**Lee** sides of ridges and mesas, 8,000-9,300 ft* (AMUT-AMAL2/NAVI4-LEKI2).

No. Samples/L&G/S:	23/17/16	Average Elevation:	8,561 ft (8,000-9,250 ft)
Landforms and Geology:		Average Aspect:	29°M (r = 0.36)
Ridges and soil creep slopes, less often mesas		Average Slope:	24% (8-54%)
Upper backslopes and shoulders, less often summits or lower backslopes		Average Coarse in Soil:	50% (17-84%)
Linear to convex horizontally, linear to **concave** vertically		Average Soil Depth:	82 cm (31-183 cm)
Tertiary tuffs and breccias, less often Cretaceous shales or sandstones, rarely schists		Average Mollic Depth:	31 cm (4-64 cm)
Usually leeward, less often other		Average Surface Coarse:	10% (0-65%)
Soils:		Average Bare Surface:	7% (0-24%)
Argiborolls (**often Pachic**), less often Haploborolls, rarely Ustochrepts		Average Tree Cover:	0% (0-0%)
Surface not coarse, less often gravelly, rarely cobbly		Average Shrub Cover:	90% (32-189%)
Surface texture various, usually loamy		Average Graminoid Cover:	64% (5-109%)
Subsurface various, often clayey		Average Forb Cover:	19% (0-62%)
Parent colluvial, residual, or colluvial over residual, rarely old-alluvial		Average Total Live Cover:	172.4% (57.6-332.4%)
Deep to moderately deep, less often very deep, rarely shallow		Average No. Species:	32 (19-45)

SA5 – *Saskatoon serviceberry/elk sedge–Deep Argiborolls and Argic Cryoborolls, often Pachic–**Lee** slopes on ridges and mesas, 8,500-9,900 ft* (AMAL2/CAGE2).

No. Samples/L&G/S:	26/26/17	Average Elevation:	9,113 ft (8,580-9,840 ft)
Landforms and Geology:		Average Aspect:	108°M (r = 0.17)
Ridges and soil creep slopes, less often mesas		Average Slope:	25% (6-75%)
Upper backslopes, summits, and shoulders, less often lower backslopes		Average Coarse in Soil:	46% (11-82%)
Usually linear both directions, less often convex horizontally or concave vertically		Average Soil Depth:	58 cm (14-99 cm)
Jurassic-Cretaceous sandstones, shales, and mudstones, less often granites, gneisses, or schists		Average Mollic Depth:	28 cm (12-63 cm)
Usually leeward, less often other		Average Surface Coarse:	11% (0-37%)
Soils:		Average Bare Surface:	5% (0-15%)
Argiborolls (**sometimes Pachic**), less often Haploborolls or Argic Cryoborolls, rarely Cryochrepts		Average Tree Cover:	1% (0-10%)
Surface not coarse, less often gravelly, stony, or cobbly		Average Shrub Cover:	73% (10-216%)
Surface texture various, usually loams, sandy loams, or clay loams		Average Graminoid Cover:	70% (9-135%)
Subsurface various, usually clays, sandy loams, or sandy clay loams		Average Forb Cover:	25% (4-69%)
Parent colluvial, less often colluvial over residual or residual, rarely old-alluvial		Average Total Live Cover:	169.2% (83.8-306.4%)
Deep, less often moderately deep, rarely shallow		Average No. Species:	36 (14-48)

SA6 – *Saskatoon serviceberry/Thurber fescue–Deep **Argic** Cryoborolls, loam surface–Subalpine slopes, 8,700-10,000 ft* (AMAL2/FETH). The soils of this ecological types are more Mollic – darker and more organically enriched in surface horizons – than the preceding type (SA5).

No. Samples/L&G/S:	8/10/8	Average Elevation:	9,084 ft (8,780-9,925 ft)
Landforms and Geology:		Average Aspect:	57°M (r = 0.35)
Soil creep slopes, less often ridges, slump-earthflows, or rockslides		Average Slope:	34% (17-50%)
Lower backslopes, backslopes, and upper backslopes, less often footslopes		Average Coarse in Soil:	52% (5-78%)
Linear horizontally, less often concave, **concave** to linear vertically		Average Soil Depth:	64 cm (48-78 cm)
Cretaceous-Jurassic sandstones, mudstones, and shales, less often granites, rarely breccias		Average Mollic Depth:	42 cm (24-75 cm)
Usually not leeward, less often leeward		Average Surface Coarse:	7% (0-20%)
Soils:		Average Bare Surface:	6% (1-14%)
Cryoborolls, usually **Argic**, **sometimes Pachic** as well		Average Tree Cover:	0% (0-0%)
Surface not coarse, less often gravelly or cobbly, rarely stony		Average Shrub Cover:	67% (22-110%)
Surface loams, sandy loams, or clay loams, less often silt loams		Average Graminoid Cover:	91% (47-140%)
Subsurface various, usually clayier than surface		Average Forb Cover:	45% (14-78%)
Parent colluvial		Average Total Live Cover:	203.7% (173.3-254.3%)
Deep, less often moderately deep		Average No. Species:	37 (28-43)

26. Rocky Tall-Shrublands Ecological Series (HODI-JUCO6-PEFL15-RHART-RICE-RUID)

SA7 – Ocean-spray-common juniper-shrubby cinquefoil-skunkbrush-wax currant-raspberry–Extremely rocky (HODI-JUCO6-PEFL15-RHART-RICE-RUID). This type occurs on sites similar to Rocky Mountain juniper sites, but **colder** and **coarser**. Here, there is often almost no exposed fine soil material. Bare soil cover is lower than expected, because rock cover is very high – there is little soil.

No. Samples/L&G/S:	9/9/0	Average Elevation:	10,028 ft (9,280-11,800 ft)
Landforms and Geology:		Average Aspect:	161°M (r = 0.33)
Rockslides and soil creep slopes		Average Slope:	72% (36-214%)
Backslopes, less often lower backslopes		Average Coarse in Soil:	
Linear to convex horizontally, linear vertically		Average Soil Depth:	28 cm
Granites and gneisses, less often Tertiary welded tuffs, rarely shales		Average Mollic Depth:	0 cm
Soils:		Average Surface Coarse:	61% (12-98%)
Soils not sampled		**Average Bare Surface:**	**5% (1-8%)**
Surface usually extremely rocky, less often cobbly or stony		Average Tree Cover:	0% (0-0%)
		Average Shrub Cover:	46% (5-92%)
		Average Graminoid Cover:	19% (1-76%)
		Average Forb Cover:	14% (6-33%)
		Average Total Live Cover:	79.3% (17.0-132.9%)
		Average No. Species:	24 (16-41)

H. Dry Sagebrush Shrublands (SB)

27. Wyoming Big Sagebrush Ecological Series (ARTRW8)

*SB1 – Wyoming big sagebrush/Indian ricegrass–**Aridic** soils–Colluvial and old-alluvial benches and slopes, < 9,000 ft* (ARTRW8/ACHY). This ecological type occurs on the **driest lower** slopes, which receive the least amount of snow. The type is rare on Tertiary tuffs, because those are more likely to be at the tops of slopes.

No. Samples/L&G/S:	32/14/11	Average Elevation:	8,091 ft (7,660-8,900 ft)
Landforms and Geology:		**Average Aspect:**	**196°M (r = 0.31)**
Soil creep slopes, less often slump-earthflows, rarely other		Average Slope:	16% (1-100%)
Footslopes, toeslopes, and lower backslopes, rarely shoulders or summits		Average Coarse in Soil:	34% (3-70%)
Linear to convex horizontally, usually linear vertically, less often convex		Average Soil Depth:	87 cm (14-175 cm)
Breccias, granites, and gneisses, less often Jurassic-Cretaceous sandstones, mudstones, or shales, rarely Tertiary tuffs		Average Mollic Depth:	21 cm (0-143 cm)
Soils:		Average Surface Coarse:	23% (4-43%)
Argiborolls and Haploborolls (often Aridic), less often Haplargids		Average Bare Surface:	23% (7-46%)
Surface very gravelly to gravelly or not coarse		Average Tree Cover:	0% (0-2%)
Surface texture various, often loamy, often sandy		Average Shrub Cover:	33% (10-73%)
Subsurface various, often clayey, often loamy		Average Graminoid Cover:	35% (10-86%)
Parent colluvial, less often alluvial, rarely colluvial over residual		Average Forb Cover:	10% (2-38%)
Very deep to deep, less often shallow		Average Total Live Cover:	78.3% (30.7-133.7%)
		Average No. Species:	28 (20-51)

28. Black Sagebrush Ecological Series (ARNO4)

The black sagebrush types (SB2, SB3) in this Ecological Series occur on relatively **dry** sites, as evidenced by their **slope positions**, **shapes**, and **exposure** to wind. The landforms and soils of these types are very similar to those of the low sagebrush (ARAR8) types (SU4, SU5, and SU6), in Ecological Series 31. There is very little elevational overlap between these two Series, however, and the black sagebrush ecological types are clearly **Foothills to Montane**, as contrasted with the low sagebrush types, which are clearly **Subalpine**. When these soils occur on shales or dark-colored gneisses, what appears to be a deep Mollic epipedon based on color measurements is actually **not Mollic**, because it does not have the base saturation or organic matter required.

SB2 – *Black sagebrush/muttongrass-pine needlegrass–Coarse **Eutroboralfs**–Westerly **windward** slopes and ridges, 8,000-9,200 ft* (ARNO4/POFE-ACPI2). This ecological type is **less permeable** (has more clay and less sand), as compared with the next type (SB3). Arizona fescue (FEAR2) may not be able to grow in this ecological type.

No. Samples/L&G/S:	36/14/9	Average Elevation:	8,393 ft (8,040-9,180 ft)
Landforms and Geology:		Average Aspect:	286°M (r = 0.39)
Soil creep slopes, less often ridges or mesas, rarely slump-earthflows		Average Slope:	17% (0-50%)
Backslopes and shoulders, less often summits, rarely lower backslopes		Average Coarse in Soil:	46% (15-68%)
Convex, less often linear, in both directions		Average Soil Depth:	62 cm (18-200 cm)
Cretaceous sandstones and shales, less often gneisses, granites, or breccias		Average Mollic Depth:	11 cm (2-25 cm)
Usually **exposed to wind**		Average Surface Coarse:	38% (26-64%)
Soils:		Average Bare Surface:	16% (6-29%)
Eutroboralfs, less often Haploborolls		Average Tree Cover:	0% (0-1%)
Surface gravelly (sometimes small-gravelly), less often cobbly, rarely stony		Average Shrub Cover:	33% (21-50%)
Surface **clay** loams, **clays**, and sandy **clay** loams, rarely loams		Average Graminoid Cover:	32% (4-100%)
Subsurface **clays**, sandy **clays**, and sandy **clay** loams, less often clay loams		Average Forb Cover:	11% (3-49%)
Parent colluvial, less often colluvial over residual or alluvial, rarely residual		Average Total Live Cover:	75.9% (39.0-131.5%)
Deep to moderately deep, rarely very deep		Average No. Species:	27 (12-41)

SB3 – *Black sagebrush/Arizona fescue–Coarse Smectitic **Eutroboralfs**–Southwesterly **windward** low-angle slopes and mesas, 8,000-9,400 ft* (ARNO4/FEAR2). This ecological type is **more permeable** (has less clay and more sand), as compared with the previous type (SB2). This may reflect the requirements of Arizona fescue (FEAR2).

No. Samples/L&G/S:	13/9/7	Average Elevation:	8,819 ft (8,080-9,340 ft)
Landforms and Geology:		Average Aspect:	250°M (r = 0.47)
Soil creep slopes or mesas, rarely ridges or slump-earthflows		Average Slope:	18% (2-53%)
Shoulders, less often backslopes, rarely summits or lower backslopes		Average Coarse in Soil:	67% (48-87%)
		Average Soil Depth:	50 cm (25-85 cm)
Convex, less often linear, in both directions		Average Mollic Depth:	14 cm (8-19 cm)
Tertiary tuffs and breccias, less often Cretaceous shales		Average Surface Coarse:	56% (35-78%)
Usually **exposed to wind**		Average Bare Surface:	8% (1-22%)
Soils:		Average Tree Cover:	0% (0-1%)
Eutroboralfs		Average Shrub Cover:	31% (11-44%)
Surface small-gravelly, less often large-gravelly		Average Graminoid Cover:	27% (14-43%)
Surface sandy loams and sandy clay loams, less often clay loams or silty clay loams		Average Forb Cover:	12% (3-30%)
		Average Total Live Cover:	69.3% (41.5-91.8%)
Subsurface clays, less often sandy loams, sandy clays, or clay loams, rarely loams		Average No. Species:	30 (18-41)
Parent colluvial or residual, less often colluvial over residual			
Moderately deep, less often shallow or deep			

I. Big Sagebrush Shrublands (SS)

29. Big Sagebrush-Antelope Bitterbrush Ecological Series (ARTR2-PUTR2)

These six types all have big sagebrush (ARTR2). They seem to be a sort on potential dominance of four key species – bitterbrush, Parry oatgrass, Arizona fescue, and mountain muhly (sometimes replaced by slimstem muhly?). We have chosen to use muhly for phase distinctions, not shown here. The other three are all decreasers and palatable to herbivores. At potential, Parry oatgrass seems not to occur without Arizona fescue; considering that, there is every other combination of these three species.

SS1 – *Big sagebrush/muttongrass-pine needlegrass–Argiborolls, sometimes Pachic–Colluvial or residual southerly to westerly slopes and summits, 8,000-10,200 ft* (ARTR2/POFE-ACPI2). Note the very low *r* value for aspect, meaning that aspect is highly variable. In general, all the site characteristics for this ecological type are highly variable; there do not appear to be strongly distinctive characteristics for this type. This would support the conclusion that this is a "climatic climax" for the (Lower) **Montane** belt, responding primarily to the macroclimate of the (Lower) **Montane** belt.

No. Samples/L&G/S:	31/23/16	Average Elevation:	8,653 ft (8,000-10,160 ft)
Landforms and Geology:		Average Aspect:	292°M (**r = 0.04**)
Soil creep slopes, less often mesas, ridges, benches, or fan remnants, rarely terraces		Average Slope:	12% (1-49%)
		Average Coarse in Soil:	44% (7-67%)
All slope positions except bottoms, often backslopes		Average Soil Depth:	58 cm (31-128 cm)
Usually linear in both directions, less often convex or concave one direction		Average Mollic Depth:	28 cm (0-51 cm)
		Average Surface Coarse:	13% (0-28%)
Geology various, reflecting relative distribution across lower 1/3 of Basin		Average Bare Surface:	19% (1-65%)
		Average Tree Cover:	0% (0-1%)
Soils:		Average Shrub Cover:	39% (11-73%)
Argiborolls		Average Graminoid Cover:	49% (14-115%)
Surface gravelly (sometimes very much so), less often not coarse		Average Forb Cover:	29% (3-78%)
		Average Total Live Cover:	116.1% (54.3-183.4%)
Surface texture various, often **clay** loams, silty **clay** loams, **clays**, or loams		Average No. Species:	31 (15-46)
Subsurface various, often clays, usually **clayier** than surface			
Parent colluvial, less often alluvial, rarely colluvial over residual or residual			
Moderately deep to deep			

SS2 – *Bitterbrush-sagebrush/needle-and-thread-pine needlegrass–Argiborolls and Haploborolls, **Sandy** to Loamy–Somewhat protected backslopes and footslopes, < 9,100 ft* (PUTR2-ARTR2/HECO26-ACPI2). This ecological type has a significantly **sandier subsurface**, as compared with big sagebrush types without bitterbrush (for example, SS1 or SS3).

No. Samples/L&G/S: 56/15/11

Landforms and Geology:
- Soil creep slopes, less often benches, rarely ridges, mesas, alluvial fans, hills, or terraces
- Backslopes or footslopes, less often shoulders
- Convex to linear horizontally, linear to convex vertically
- Granites, gneisses, and schists, less often Cretaceous sandstones or shales

Soils:
- Haploborolls or Argiborolls, rarely Orthents
- **Surface gravelly (sometimes very much so)**, less often not coarse
- Surface texture various, often sandy, usually loamy
- **Subsurface usually sandy**: loamy sands, sandy loams, sandy clay loams, or sandy clays
- Parent colluvial, less often alluvial, rarely colluvial over residual
- Moderately deep to deep

Average Elevation:	8,660 ft (7,980-9,660 ft)
Average Aspect:	229°M (r = 0.30)
Average Slope:	16% (2-40%)
Average Coarse in Soil:	37% (0-73%)
Average Soil Depth:	51 cm (0-107 cm)
Average Mollic Depth:	25 cm (0-61 cm)
Average Surface Coarse:	17% (2-45%)
Average Bare Surface:	9% (2-25%)
Average Tree Cover:	0% (0-6%)
Average Shrub Cover:	50% (21-106%)
Average Graminoid Cover:	36% (3-76%)
Average Forb Cover:	17% (2-120%)
Average Total Live Cover:	103.0% (31.0-205.1%)
Average No. Species:	24 (10-44)

SS3 – *Big sagebrush/Parry oatgrass-Arizona fescue–Mollisols with an Argillic horizon– Gentle to moderate lower-backslopes and toeslopes, 8,800-10,200 ft* (ARTR2/DAPA2-FEAR2). This type is somewhat cooler and moister than SS1, since this type tends to be at higher elevations. This type is often adjacent to mixed Douglas-fir and aspen forest, which occurs on steeper, coarser slopes – they are better drained than the slopes with this type. This type seems to be a "climatic climax" for the (Upper) **Montane** belt, responding primarily to the macroclimate of the (Upper) **Montane** belt.

No. Samples/L&G/S: 17/12/12

Landforms and Geology:
- Soil creep slopes or mesas, rarely slump-earthflows, hillslopes, or benches
- **Lower backslopes** and backslopes, less often **footslopes**, rarely toeslopes, toeslopes, or shoulders
- Linear or convex horizontally, linear vertically, less often concave
- Tertiary tuffs, rhyolites, lavas, basalts, andesites, and breccias, rarely Jurassic sandstones or siltstones, rarely granites

Soils:
- Argiborolls, rarely Haploborolls or Eutroboralfs
- **Surface gravelly (sometimes very much so)** or not coarse, rarely stony
- Surface loamy, rarely clayey
- **Subsurface clayey**, sometimes loamy, clayier than surface
- Parent slope alluvium or colluvial, rarely colluvial over residual or slope alluvium over residual
- Deep, less often moderately deep or shallow

Average Elevation:	9,451 ft (8,990-10,110 ft)
Average Aspect:	144°M (r = 0.11)
Average Slope:	18% (6-47%)
Average Coarse in Soil:	41% (16-65%)
Average Soil Depth:	56 cm (37-81 cm)
Average Mollic Depth:	26 cm (6-59 cm)
Average Surface Coarse:	17% (0-47%)
Average Bare Surface:	14% (3-28%)
Average Tree Cover:	0% (0-0%)
Average Shrub Cover:	30% (12-58%)
Average Graminoid Cover:	80% (50-142%)
Average Forb Cover:	32% (16-61%)
Average Total Live Cover:	142.7% (94.3-207.7%)
Average No. Species:	34 (26-43)

SS4 – *Big sagebrush/Arizona fescue–Mollisols with or without an Argillic horizon–Gentle to moderate summits, shoulders, and backslopes, 8,600-10,200 ft* (ARTR2/FEAR2). This ecological type is **better drained** than the preceding type (SS3).

No. Samples/L&G/S:	30/27/24	Average Elevation:	9,189 ft (8,620-10,120 ft)
Landforms and Geology:		Average Aspect:	272°M (r = 0.24)
Soil creep slopes, less often mesas, ridges, or benches, rarely hills or saddles		Average Slope:	16% (0-51%)
Shoulders, summits, and upper backslopes, less often lower backslopes, rarely toeslopes or footslopes		Average Coarse in Soil:	53% (16-88%)
Usually linear in both directions, less often convex in one direction		Average Soil Depth:	63 cm (27-140 cm)
Tertiary tuffs (some welded) and breccias, less often Tertiary shales, sandstones, or siltstones, less often granites, rarely andesites, lavas, felsites, or basalts		Average Mollic Depth:	21 cm (0-48 cm)
Soils:		Average Surface Coarse:	24% (0-60%)
Argiborolls (sometimes Pachic), less often Haploborolls or Eutroboralfs, rarely Ochrepts or Cryoboralfs		Average Bare Surface:	15% (1-35%)
Surface gravelly (often very much or extremely so), less often not coarse, rarely stony or cobbly		Average Tree Cover:	0% (0-0%)
Surface texture variable, usually loamy		Average Shrub Cover:	35% (13-58%)
Subsurface variable, often clayier than surface		Average Graminoid Cover:	60% (26-116%)
Parent colluvial, less often residual or colluvial over residual, rarely slope alluvium or alluvial		Average Forb Cover:	20% (0-67%)
Deep, less often moderately deep, rarely very deep or shallow		Average Total Live Cover:	114.4% (60.7-174.5%)
		Average No. Species:	32 (21-45)

SS5 – *Bitterbrush-sagebrush/Parry oatgrass-Arizona fescue–**Haplustalfs**–**Northerly** gentle to moderate backslopes and toeslopes, 8,700-9,000 ft* (PUTR2-ARTR2/DAPA2-FEAR2).

No. Samples/L&G/S:	7/7/4	Average Elevation:	8,839 ft (8,700-8,960 ft)
Landforms and Geology:		Average Aspect:	3°M (r = 0.40)
Soil creep slopes		Average Slope:	16% (8-23%)
Lower backslopes and backslopes, rarely toeslopes		Average Coarse in Soil:	43% (26-66%)
Usually convex horizontally, linear vertically		Average Soil Depth:	66 cm (40-106 cm)
Tertiary breccias, tuffs, or rhyolites, less often granites or Cretaceous shales		Average Mollic Depth:	14 cm (8-26 cm)
Soils:		Average Surface Coarse:	26% (7-43%)
Argiborolls and **Haplustalfs**		Average Bare Surface:	18% (7-35%)
Surface gravelly, sometimes very much so		Average Tree Cover:	0% (0-0%)
Surface texture variable, usually loamy		Average Shrub Cover:	35% (6-57%)
Subsurface variable, usually clayier than surface		Average Graminoid Cover:	71% (50-87%)
Parent colluvial		Average Forb Cover:	23% (14-35%)
Deep		Average Total Live Cover:	128.7% (106.5-164.8%)
		Average No. Species:	37 (30-46)

SS6 – *Bitterbrush-sagebrush/Arizona fescue–Argiborolls and Haploborolls–**Non-northerly** summits, shoulders, and backslopes, 8,300-9,600 ft* (PUTR2-ARTR2/FEAR2). This ecological type is **warmer**, **drier**, and **better drained** than the preceding type (SS5).

No. Samples/L&G/S:	38/19/16	Average Elevation:	8,783 ft (8,050-9,600 ft)
Landforms and Geology:		Average Aspect:	229°M (r = 0.27)
Soil creep slopes, less often ridges or mesas, rarely benches or slump-earthflows		Average Slope:	21% (3-50%)
Upper backslopes and backslopes, less often **shoulders and summits**, rarely lower backslopes or footslopes		Average Coarse in Soil:	57% (11-86%)
Usually linear to convex in both directions, less often undulating		Average Soil Depth:	75 cm (32-182 cm)
Tertiary welded tuffs (often sandy), less often pyroxenites or granites, rarely breccias, andesites, gneisses, or lavas		Average Mollic Depth:	23 cm (0-54 cm)
Soils:		Average Surface Coarse:	24% (2-67%)
Argiborolls, less often Haploborolls, rarely Ustochrepts or Haplustalfs		Average Bare Surface:	14% (0-45%)
Surface gravelly (sometimes very much or extremely so), less often cobbly (sometimes very much or extremely so), rarely stony		Average Tree Cover:	0% (0-2%)
Surface texture variable		Average Shrub Cover:	48% (15-80%)
Subsurface variable, **often sandy**		Average Graminoid Cover:	54% (12-147%)
Parent colluvial over residual and colluvial, less often residual, rarely slope alluvium		Average Forb Cover:	11% (2-49%)
Mostly Moderately Deep, less often Deep, Very Deep, or Shallow		Average Total Live Cover:	113.4% (60.5-216.4%)
		Average No. Species:	29 (12-45)

J. Subalpine Sagebrush Shrublands (SU)

30. Mountain Big Sagebrush Ecological Series (ARTRV)

SU1 – *Mountain big sagebrush/Thurber fescue-Arizona fescue–Deep Argic Cryoborolls–Moderate slopes, 8,500-10,300 ft* (ARTRV/FETH-FEAR2). This ecological type appears to be **warmer** than the next type (SU2), as shown by the southerly aspects and somewhat lower elevations; but both SU1 and SU2 are warmer than SU3.

No. Samples/L&G/S:	45/31/16	Average Elevation:	9,422 ft (8,560-10,220 ft)
Landforms and Geology:		**Average Aspect:**	**168°M** (r = 0.19)
Soil creep slopes, rarely mesas, ridges, benches, or slump-earthflows		Average Slope:	17% (0-45%)
Backslopes, rarely footslopes, summits, toeslopes, or shoulders		Average Coarse in Soil:	42% (15-78%)
Linear in both directions, less often convex horizontally or concave vertically		Average Soil Depth:	73 cm (33-137 cm)
Cretaceous-Jurassic shales, sandstones, and mudstones, less often Tertiary tuffs, breccias, basalts, or schists, rarely other		Average Mollic Depth:	36 cm (17-62 cm)
Soils:		Average Surface Coarse:	4% (0-14%)
Cryoborolls, usually Argic, sometimes Pachic as well		Average Bare Surface:	7% (0-23%)
Surface not coarse, less often gravelly, rarely cobbly or stony		Average Tree Cover:	0% (0-8%)
Surface texture loams, silt loams, and clay loams, rarely other, usually loamy		Average Shrub Cover:	50% (10-135%)
Subsurface clay loams and clays, rarely other, usually clayier than surface		Average Graminoid Cover:	97% (50-170%)
Parent colluvial, rarely residual, old-alluvial, colluvial over residual, or slope alluvium		Average Forb Cover:	46% (3-110%)
Deep, less often moderately deep or very deep, rarely shallow		Average Total Live Cover:	193.5% (120.9-340.0%)
		Average No. Species:	26 (10-46)

SU2 – *Mountain big sagebrush/Thurber fescue-Idaho fescue–Deep Argic Cryoborolls–Slopes and mesas, 8,800-10,400 ft* (ARTRV/FETH-FEID). This ecological type appears to be **cooler** than the previous type (SU1), as shown by the northerly aspects and somewhat higher elevations; but both SU1 and SU2 are warmer than SU3.

No. Samples/L&G/S:	15/11/6	Average Elevation:	9,585 ft (8,820-10,400 ft)
Landforms and Geology:		**Average Aspect:**	**328°M** (r = 0.28)
Soil creep slopes, less often mesas, rarely benches or fan remnants		Average Slope:	12% (4-26%)
Backslopes or footslopes, less often summits, rarely toeslopes		Average Coarse in Soil:	32% (7-59%)
Linear in both directions, less often convex horizontally or concave vertically		Average Soil Depth:	85 cm (63-98 cm)
Cretaceous sandstones and mudstones and granites, less often conglomerates or Permian shales, rarely sandy tuffs		Average Mollic Depth:	26 cm (15-46 cm)
Soils:		Average Surface Coarse:	3% (0-11%)
Cryoborolls, usually Argic, rarely Pachic		Average Bare Surface:	11% (1-30%)
Surface not coarse, rarely gravelly		Average Tree Cover:	0% (0-0%)
Surface texture loams, less often silty clay loams or sandy loams		Average Shrub Cover:	28% (6-65%)
Subsurface clays and sandy clay loams, clayier than surface		Average Graminoid Cover:	95% (14-225%)
Parent colluvial, less often residual, rarely alluvial		Average Forb Cover:	51% (16-105%)
Deep, less often very deep		Average Total Live Cover:	174.4% (78.8-311.0%)
		Average No. Species:	25 (12-46)

SU3 – *Mountain big sagebrush/Idaho fescue–Deep,* ***sandy*** *Cryic soils–****Glacial*** *outwash terraces and moraines, 9,400-10,000 ft* (ARTRV/FEID). In this ecological type, the soils are **very well drained**; they are on glacial surfaces derived from granite and gneiss, which are high in sand and low in clay. The sites in this ecological type are **colder** than other big sagebrush types, because they are in lower landscape positions in the bottoms of mountain parks, where cold air drainage has a significant effect.

No. Samples/L&G/S:	14/15/10	Average Elevation:	9,666 ft (9,440-9,940 ft)
Landforms and Geology:		Average Aspect:	283°M (r = 0.09)
Outwash terraces, less often end moraines		Average Slope:	7% (1-26%)
Usually not on a slope, less often shoulders or backslopes		Average Coarse in Soil:	43% (21-72%)
Linear to undulating horizontally, mostly linear vertically		Average Soil Depth:	62 cm (50-79 cm)
Granites, less often gneisses		Average Mollic Depth:	7 cm (0-25 cm)
Soils:		Average Surface Coarse:	14% (1-42%)
Cryoborolls (often Argic) and Cryochrepts		Average Bare Surface:	11% (3-25%)
Surface gravelly (often very much so) or not coarse		Average Tree Cover:	0% (0-0%)
Surface texture various, usually loamy		Average Shrub Cover:	24% (14-39%)
Subsurface often **sandy**, usually loamy sands, sandy clay loams or sandy loams		Average Graminoid Cover:	71% (38-103%)
Parent glacial		Average Forb Cover:	36% (13-67%)
Deep		Average Total Live Cover:	131.5% (90.0-157.3%)
		Average No. Species:	31 (25-36)

31. Low Sagebrush Ecological Series (ARAR8)

The low sagebrush types (SU4, SU5) in this Ecological Series occur on relatively **dry** sites (for the Subalpine), as evidenced by their **slope positions**, and **shapes**. The landforms and soils of these types are very similar to those of the black sagebrush (ARNO4) types (SB2 and SB3), in Ecological Series 28. There is very little elevational overlap between these two Series, however, and the low sagebrush ecological types are clearly **Subalpine**, as contrasted with the black sagebrush types, which are clearly **Foothills to Montane**. Where these soils occur on shales, mudstones, or dark-colored gneisses, what appears to be a deep Mollic epipedon based on color measurements is actually **not Mollic**, because it does not have the base saturation or organic matter required.

SU4 – *Low sagebrush/Parry oatgrass-Idaho fescue–****Smectitic Cryoboralfs****–****Exposed*** *Subalpine slopes and ridges, 9,200-10,500 ft* (ARAR8/DAPA2-FEID).

No. Samples/L&G/S:	25/23/19	Average Elevation:	9,618 ft (9,210-10,490 ft)
Landforms and Geology:		Average Aspect:	259°M (r = 0.54)
Soil creep **slopes and ridges**, less often slump-earthflows or benches, rarely mesas or lateral moraines		Average Slope:	14% (8-31%)
Backslopes, summits, and shoulders, less often footslopes, rarely toeslopes		Average Coarse in Soil:	33% (0-66%)
Convex to linear horizontally, linear to **convex** vertically		Average Soil Depth:	85 cm (46-140 cm)
Cretaceous-Jurassic shales, sandstones, and mudstones, less often gneisses, granites, and schists, rarely tuffs, basalts, conglomerates, or quartzites		Average Mollic Depth:	24 cm (0-87 cm) (evidenced by color only)
Soils:		Average Surface Coarse:	8% (0-41%)
Cryoboralfs		Average Bare Surface:	11% (0-31%)
Surface not coarse, less often gravelly, rarely cobbly		Average Tree Cover:	0% (0-1%)
Surface texture various, usually clay loams, loams, clays, or silt loams		Average Shrub Cover:	32% (5-61%)
Subsurface clays, less often clay loams, rarely other		Average Graminoid Cover:	76% (38-116%)
Parent residual or colluvial, less often alluvial over residual or old-alluvial, rarely slope alluvium or glacial		Average Forb Cover:	54% (8-127%)
Deep, less often very deep		Average Total Live Cover:	161.6% (109.0-241.1%)
		Average No. Species:	33 (12-49)

SU5 – *Low sagebrush-Mountain big sagebrush/Parry oatgrass-Idaho fescue–**Smectitic Cryoboralfs**–**Exposed** Subalpine ridges, 9,000-10,000 ft* (ARAR8-ARTRV/DAPA2-FEID).

No. Samples/L&G/S:	5/2/2	Average Aspect:	259°M (r = 0.54)
Landforms and Geology:		Average Slope:	10% (10-10%)
Ridges		Average Coarse in Soil:	19% (19-20%)
Summits and shoulders		Average Soil Depth:	73 cm (26-120 cm)
Linear to **convex horizontally**, convex or concave vertically		Average Mollic Depth:	27 cm (3-51 cm)
Jurassic mudstones and sandstones, granites, and gneisses			(evidenced by color only)
Soils:		Average Surface Coarse:	1% (1-1%)
Cryoboralfs		Average Bare Surface:	4% (2-5%)
Surface not coarse		Average Tree Cover:	0% (0-0%)
Surface texture clay loams		Average Shrub Cover:	52% (31-66%)
Subsurface clays		Average Graminoid Cover:	83% (37-150%)
Parent residual or old-alluvial		Average Forb Cover:	47% (19-109%)
Very deep		Average Total Live Cover:	182.4% (128.5-236.0%)
Average Elevation:	9,460 ft (9,000-9,920 ft)	Average No. Species:	22 (12-40)

SU6 – *Low sagebrush/Parry oatgrass-Thurber fescue-Idaho fescue–**Argic Cryoborolls**–Subalpine slopes, 8,9-0-10,600 ft* (ARAR8/DAPA2-FETH-FEID).

No. Samples/L&G/S:	4/4/4	Average Aspect:	89°M (r = 0.24)
Landforms and Geology:		Average Slope:	18% (8-40%)
Soil creep slopes, less often debris flows or lateral moraines		Average Coarse in Soil:	54% (30-77%)
Upper backslopes, toeslopes, or **summits**		Average Soil Depth:	93 cm (56-139 cm)
Linear to **convex horizontally**, linear vertically		**Average Mollic Depth:**	**48 cm (24-106 cm)**
Geology various			(evidenced by color only)
Soils:		Average Surface Coarse:	13% (3-32%)
Argic Cryoborolls		Average Bare Surface:	15% (13-19%)
Surface not coarse or gravelly, less often cobbly		Average Tree Cover:	0% (0-0%)
Surface texture various		Average Shrub Cover:	26% (18-34%)
Subsurface various		Average Graminoid Cover:	87% (44-126%)
Parent colluvial, less often old-alluvial or glacial		Average Forb Cover:	40% (21-65%)
Very deep to deep, less often moderately deep		Average Total Live Cover:	153.2% (134.4-164.1%)
Average Elevation:	9,753 ft (8,980-10,530 ft)	Average No. Species:	30 (19-36)

32. Silver Sagebrush Ecological Series (ARCA13)

SU7 – *Silver sagebrush/Thurber fescue-Idaho fescue–Cryoborolls–Benches, mesas, and parks, 8,900-10,400 ft* (ARCA13/FETH-FEID). This ecological type is relatively **moister** than other sagebrush types; but these is less moisture than needed for willows, especially at the surface. The **lower slope positions** mean that water usually "runs on" to these sites rather than "runs off." The soil parent material, especially the uppermost layer, was typically deposited by **slope wash (slope alluvium)**. The soils are fine-textured, hence they have higher water-holding capacity than other sagebrush types, so they are more productive: note the high cover for graminoids. Mostly the slope angles are low, but the sites towards the high end of the stated range in slope angles are on fans and slump-earthflow complexes where there is greater moisture input.

No. Samples/L&G/S:	10/9/6	Average Elevation:	9,822 ft (8,900-10,390 ft)
Landforms and Geology:		Average Aspect:	4°M (r = 0.42)
Soil creep slopes, less often mesas or swales, rarely slump-earthflows or alluvial fans		**Average Slope:**	**8% (4-15%)**
Toeslopes and footslopes, rarely other		Average Coarse in Soil:	19% (11-42%)
Concave horizontally, less often convex, linear to **concave vertically**		Average Soil Depth:	96 cm (44-154 cm)
		Average Mollic Depth:	**25 cm (20-30 cm)**
		Average Surf. Coarse:	**2% (0-5%)**
Jurassic-Cretaceous mudstones and sandstones, less often Tertiary tuffs, less often gneisses or granites		Average Bare Surface:	16% (1-34%)
		Average Tree Cover:	0% (0-0%)
Soils:		Average Shrub Cover:	31% (17-45%)
Cryoborolls (usually Argic), less often Argic Cryaquolls		**Average Gram. Cover:**	**102% (62-148%)**
Surface not coarse		Average Forb Cover:	65% (21-195%)
Surface texture usually **silty**, usually **loamy**		Average Total Live Cover:	198.4% (128.1-355.0%)
Subsurface various, usually clayey		Average No. Species:	27 (14-40)
Parent **slope alluvium** over alluvial, colluvial, or residual, rarely just colluvial or just residual			
Deep, less often very deep			